THE TELEGRAPHIC JOURNAL AND

ELECTRICAL REVIEW.

VOL. XXVIII. MAY 1, 1891. No. 701

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THE LONDON TELEPHONE SERVICE.

THE representative of a contemporary has been interviewing Mr. Hastie, the promoter of an association for securing a better telephonic service in London. First of all, it is the desire of Mr. Hastie and his supporters to get the double wire or metallic circuit system established throughout the metropolis, so that the apparatus may be used with some degree of certainty of understanding what is said, and of being understood. There is not the slightest doubt that as the telephone system stands at the present moment it is a much greater annoyance than it is worth, and in any case the service is paid for rather heavily, even if perfect talking could be ensured. How the matter can best be set right is probably only known to the National Telephone Company's officials, but we do not think that Mr. Hastie has quite grasped the situation. It is useless to talk of country subscribers getting telephones on easier terms than Londoners, and insisting that £12 should be a maximum charge in town, unless it can clearly be shown that the company can work profitably at the lower rate.

Mr. Hastie would do well to enter into statistics before attempting by means of his combination of subscribers to place undue pressure upon the company. Let him ascertain the relative cost of construction, maintenance, and working of lines in London and the country before leading people to believe that it is possible to have a telephonic service here at a lower rate even than the sum previously mentioned. Let him also estimate the cost entailed in substituting metallic circuits for the present lines, and he will then probably learn that some consideration is due to the National Telephone Company.

Mr. Hastie does not see why we should not talk through to Dublin, Edinburgh, Liverpool and Manchester, as easily as we can to Paris; probably he did not consider that the London-Paris line cost the greater part of £100,000, and that as a commercial venture, it may not prove successful. Would Mr. Hastie and his friends guarantee a fair return on the heavy outlay necessitated in running heavy copper conductors to the places he names? Indeed, his arguments seem rather inconsistent, for on the one hand he advocates a great reduction in the cost of the service, and on the other an immense expenditure of capital on lines which might never return a reasonable dividend on the money expended.

We have never sympathised unduly with the telephone company, and we have every desire to see the bad service improved both as regards cost and efficiency by legitimate means, but we think that an organisation such as Mr. Hastie has created should at least know something of the technicalities of the situation and the difficulties which must be encountered before even slight improvements can be carried out in such a network of wires as the company has stretched in and about London.

There is this at least to be said, Mr. Hastie does not wish to create competition from rival companies, although he has been in communication with the Postmaster-General, who, it seems, would not object to establishing a telephone service if generally demanded.

The National Telephone Company must not overlook the probability of this being brought about, and in its own interests it should at once take whatever steps are considered most advisable to satisfy its subscribers before Mr. Hastie and his friends further develop their demands.

THE LATE COPPER SYNDICATE.

UNDER this heading we noticed in last Friday's *Evening Standard* the following telegram, dated Paris, April 24th:—"The Court of Cassation has rejected the appeal of M. Secrétan, the ex-President of the Société des Métaux, against the decree of the Court of Appeal of August 5th, 1890, condemning him to six months' imprisonment for distributing fictitious dividends."

Now, this gentleman has, of late, figured more or less prominently in our pages in connection with another copper business, viz., that of Elmores, and in his hands mainly rest, or did rest, the fortunes of the French Elmore Com-

pany. In our issue of January 16th, in which we reported the meeting of that company, the Chairman remarked:—"Your directors are confident, from all they have learned and know of him, that in placing him at the head of the company's affairs in France they have taken the most important step that was possible towards securing the complete and early success of the business of the company in that country." A shareholder who had the temerity to doubt the integrity of M. Secrétan was silenced by Mr. F. L. Rawson stating that his firm, Woodhouse and Rawson, had the highest opinion of that gentleman's great capacity as a metallurgist and of his knowledge of business as a manufacturer. When Mr. Rawson found there was a chance of M. Secrétan coming as manager to the company, he exclaimed, not exactly "Eureka!" but "the future of the company is assured."

Now, Mr. Rawson could not have been entirely ignorant of M. Secrétan's antecedents, and it would be interesting to learn what opinion his firm still holds of the man who appears to make it part of his business to distribute fictitious dividends? We are almost inclined to think that Mr. Rawson was laughing in his sleeve when he spoke of M. Secrétan as a metallurgist, and that this expression was only another term for being versed in the art of making money. It is also open to doubt what was intended to be conveyed by the "future" of the company being assured.

In a letter which appeared in the REVIEW on the 23rd January last, an innocent and trusting nature is revealed by the following lines:—"I am myself content to rely upon the word of such well known men as have seen the works, and who have been satisfied with them, such as M. Secrétan, whose knowledge of the copper industry places him *facile princeps* in the copper trade, and whose integrity and honesty are now admitted by even his worst enemies."

We can understand how easily an inexperienced man like the writer of the above extract is gulled by specious phrases and vague reports on a matter in which he cannot possibly have gained any technical knowledge; but it is not so easy to gauge the faith which fills the Rawsons in their French colleague, of whom they appeared so proud. We can only attribute it to their guileless nature, or consider it, as Sir Rawson Rawson said of his family at the staff dinner given last January, "as bodying forth the true English honour and enterprise in many fields of the Rawsons." As we have on other occasions, we must protest strongly against the part they have played in this copper farce.

A few more instances of this kind, and that connected with the Chief Engineer Surveyor of Lloyds, and the paper read before the Institution of Naval Architects, which Mr. Elmore has carefully avoided touching in his recent letters, and the "future" of the Elmore copper process in all countries is not difficult to foretell; a process coming before the public in such an improper way is not likely to possess much merit.

The sanguine anticipations of the Chairman of the French Elmore Company that M. Secrétan's energy would enable its works to be in operation by the 1st July, seem doomed to remain unrealised; may be this is all for the best, for, as we said at the conclusion of an article in the REVIEW of January 16th:—"The shareholders of the French company do not need energy in the establishment of a factory which absorbs their money. What they do need is the exercise of judgment which will keep the money until they can see that an English factory pays." What our advice was scarcely likely to effect, the little episode on which we have commented may perhaps accomplish.

A FRIEND TO TELEGRAPH CLERKS.

THE death, recently announced, of Mr. Peter Stewart Macliver, founder and proprietor of the Bristol *Western Daily Press*, removes from this earthly stage a gentleman who ten years ago achieved considerable prominence and popularity as the Parliamentary champion of Postal Telegraph clerks.

Though latterly on what may be termed the lee shore of Parliamentary life, the deceased gentleman sat as Liberal member for Plymouth from 1880 to 1885 during Mr. Gladstone's administration, and his voice and figure were familiar in the House of Commons during 1880 and 1881.

Earnest and tenacious, yet withal cautious and methodical, he personally devoted much time and labour to the investigation of the congested, we were about to say petrified, condition of the Postal Telegraph Service at that period, and it is questionable whether he did not really know as much of the organisation of that huge public department as the Postmaster-General—Prof. Fawcett—himself. He was much in evidence at Westminster, and he shirked neither interviews nor correspondence. By these, as well as other means, he acquired a vast amount of practical information of great value.

If we remember rightly, the blind political economist had several interviews with Mr. Macliver, and though they both sat in the Liberal interest, yet he did not regard the position taken up by the latter gentleman as personally antagonistic or unfriendly; no, that was hardly the nature of the humane Fawcett.

On the introduction of the Fawcett scheme, Mr. Macliver, whilst commending the spirit in which the Postmaster-General had approached the reform of the Telegraph Service, summed up the scheme itself as very inadequate. This we now know to have been the opinion held by Prof. Fawcett very shortly afterwards. Expressions of gratitude reached Mr. Macliver from all parts of the United Kingdom, and he ever spoke with pleasure of the part he had taken in helping to mitigate the grievances of telegraph clerks.

Prof. Fawcett, as is well known, died somewhat suddenly not long after these events took place, and Mr. Macliver disappeared for ever from Parliamentary life in the political earthquake that shattered and engulfed the party under the leadership of the "People's William."

Mr. Macliver, who was 71 years of age, had been in declining health for some time, and the death of his only son about four years ago was a blow from which his spirits never recovered.

Intimation of his death was received throughout the telegraph service, which he had done so much to improve, with every expression of sympathy and regret.

The Cable Works at Calais.

THE completion of the shipping, on board the *Westmeath*, of the cable manufactured for the Société Française des Télégraphes Sousmarins, was made the occasion of a festive gathering, on April 19th, at the works of the Société des Téléphones at Calais. In addition to the guests invited from Calais and Boulogne, a special train brought some seventy gentlemen from Paris to join in the inspection of the factory and ship, to assist at what seems to have been a sort of inaugural ceremony, and to wish success to the forthcoming expedition. The work to be undertaken by the *Westmeath* on her present (and last) trip, will include the connecting of Cape Haitien with the cable already laid between Mole St. Nicolas and Puerto Plata; the laying of the section between Puerto Plata and Martinique, about 780 knots; and the continuation, to Cayenne, of the cable between that place and Paramaribo, a portion of which was submerged on the last expedition. At Cayenne, the *Westmeath* will be joined by the *Ludgate*, now being fitted with cable machinery and tanks at Messrs. Henley's works, and the section between Cayenne and Vizen (in Brazil) will then be laid, thus completing the whole of the system owned by the Société Française des Télégraphes Sousmarins. It is expected that the work will be finished by the month of August. The French journals are jubilant, and naturally so, at the fact of a cable ship being despatched from a French port, with a considerable length of submarine telegraph cable manufactured in a French factory. The *Figaro* points out that during the last thirty years, France has paid to English manufacturers, in this particular industry, not less than fifty million francs. The government factory at La Seyne, the *Figaro* continues, though possessing sheathing machines, is only adapted for the repair of unimportant lengths of coast cables, and in the event of an European war, when English engineers and manufacturers might be employed on behalf of their own country, France would be deprived of the means of maintaining her submarine communications; now, thanks to the energy of her citizens, and the skill of her engineers, she is able to free herself from this servitude. Although a good deal of tall talk is indulged in, there is present a considerable element of truth in this self-congratulation, and to many English manufacturers, the establishment of the cable works at Calais may, no doubt, prove somewhat undesirable. Judging from the feeling very clearly evidenced in France upon the questions of foreigners and foreign manufacturers, it seems just possible that even if the Société des Téléphones had, in its operations, miscalculated the strength of its resources, the Government might be inclined to lend some active measure of support to an undertaking which, from the sentimental point of view, has managed to obtain a very general sympathy.

The Maquay Primary Battery.

THE Maquay Electric Light Company has opened show rooms at No. 9, Frith Street, Soho, with works situated in Emmett Street, Limehouse, E. The company does not profess to be able to compete in the matter of cost of light with large installations, but in those cases where a large number of lamps is not required, the firm contends that its system of electric lighting gives very satisfactory results, both as regards cost and efficiency of illumination. The Maquay primary battery, which, in another form, is an old friend of some years' standing, as readers of the REVIEW will remember, now comprises carbon and zinc plates, and a solution composed of chromic acid and other ingredients, the nature of which is withheld. The peculiar feature of the zincs is the fact that they are covered on one side with a thin coating of red paint, and as the solution is used and becomes heated to about 80° or 90°, the paint gradually peels off, thus exposing more surface to the action of the acid. This, the maker states, explains the fact of the light remaining practically of the same brilliancy during the whole of the lighting period of, say, ten or more hours, as the case may be. An elaborate series of tests made with different batteries, showed that the voltage slightly rose as the number of lighting hours increased, until the last hour or two, when the pressure almost assumed that noted on starting. Except in the case of the portable lamps, the plates are raised out of and lowered into the exciting liquid by means of screws. The company have on view a large collection of batteries and lamps shown as applied to the uses of gas engineers, miners, surgeons, dentists, for table lamps and domestic installations, &c. The consumption of zinc is said to be 30 grains per ampère hour per cell, and the carbons to last twelve months; but as to the accuracy of this statement we have no corroboration. In any case, we hope the battery has been improved since it last figured in the pages of the REVIEW.

The Photographic Action of Electro-magnetic Waves.

DRY bromide of silver and gelatine plates have been shown to be sensitive to the action of electro-magnetic waves, which produce in them a kind of photographic action. Von Dobrzynski has shown this by the following experiments: He produced electro-magnetic waves by the method discovered by Hertz, and the plates were so disposed that their plane included the axis of the vibrator or was normal to it: three hours were allowed for the exposure, and the developing and fixing operations were carried out in the ordinary way, using ferric oxalate and hyposulphite. When the plate had been thus treated, it was seen that photographic action had taken place: alternate dark and bright bands appeared across the direction of vibration of the waves or dark bands appeared in the direction of the vibration. Under certain conditions both kinds of these bands were observed together. Von Dobrzynski varied the conditions of the experiment. For instance, he covered the plate with tin-foil, and then cut portions of the latter away, but the coating did not in any way interfere with the formation of the bands. It is evident, therefore, that the chemical action which takes place cannot be regarded as a primary one. We have stated that, in some conditions, bands appeared which were both *across* and *in* the direction of the vibrations: this observation seems to suggest stationary vibrations, and should be considered in connection with some recent French researches which we have been placing before our readers. The crossed bands, however, might be due, says Von Dobrzynski, to reflection from the sides of the wooden box by which during the experiments the sensitive plates were screened from the influence of extraneous rays; they might also have been produced by reflection from the sides of the room. The plates sometimes showed two systems of crossed bands, and this would represent different waves which the vibrator emits in the sense of the discovery of MM. Edouard Sarasin and Lucien de la Rive, and in that of the view stated above, Von Dobrzynski made an experiment with a reflecting metal ball, and the results obtained in this case did not contradict this view, and greater regularity and distinctness was observed in the crossed bands. He is still carrying on experiments and pursuing his researches further in this direction, and we may expect before long some more interesting information respecting the photographic action of electro-magnetic waves.

Wiring Slide Rule.

THIS little instrument (Trotter's patent) will be found useful and handy for engineers who have much wiring to calculate out. It is portable, being about 6 inches by 3, and can therefore be carried quite flat in the breast pocket. At present the rule is constructed of cardboard, but if a large demand should arise for them the manufacturers contemplate using a more durable material, probably steel. The rule can be obtained from Messrs. Crompton & Co., Limited, and the makers say the

use of this slide rule is so simple that the ordinary British workman can easily understand it. This is quite feasible for the greater part of the data to be obtained from it, but we think the workman might have some slight difficulty in reading off the resistance of a wire in ohms so as to put the decimal point in the correct place, and again, for the same reason, in finding the sectional area of a cable in square inches. A few further words of explanation would obviate this objection and would render the instrument as useful to the semi-trained wirer as it certainly will be to the general electrical engineer. The wiring slide rule is provided with a double slide, and by its use the following seven problems can be solved :—1. To find size of cable. 2. To find length of cable. 3. To find current cable will carry with given fall in volts. 4. To find current density. 5. To find maximum current (under Board of Trade Rules). 6. To find resistance in ohms. 7. To find sectional area of cable in square inches. These problems generally contain several data, or known quantities, and one principal answer. In using the rule, the known quantities must be taken in pairs. The scales are arranged in such pairs on the meeting edges of the slide, *e.g.*, watts and volts, number of lamps and fall of potential in leads, length of cable and size of cable. Usually there are five known quantities to deal with. The divisions on the scale must be found, and one quantity must be set against another. For example, the data given are volts, 100 ; watts, 32 ; lamps, 44 ; fall of potential, 1·5 volts ; length of cable, 95 yards. To find the required size of cable, set the volts against the number of watts on upper scale, then set the fall of potential on top scale of lower slide against the number of lamps on bottom scale of upper slide. Then, on the bottom scale, under the required length of cable (going and returning) will be found the proper size of cable for the circumstances set forth. On account of its portability, as well as the practical convenience of Trotter's wiring slide rule, it may safely be predicted that the instrument will meet with a ready sale, and to would-be purchasers who might think that a cardboard scale will soon wear out, it may be stated that we have known a Hunter's steam engine slide rule—of similar make—to have been in constant use for some five years, and its owner always carried it about with him in his breast pocket.

A New Source of India-rubber.

WE have lately been favoured with some ominous statements about the future prospects of the trade in India-rubber ; unless, we are told, the sources of this valuable commodity are more jealously guarded than they have been in the past. The reckless destruction of trees, combined with the ever increasing demands for rubber created by the applications of electricity, will result in a "famine" which cannot be far distant. Some authorities, indeed, have stated that our only hope lies in the immediate discovery of some other sources of rubber which have not yet been exploited. In a paper recently published in the *Transactions of the Pharmaceutical Society*, Mr. E. M. Holmes, F.L.S., gives some description of an alleged "India-rubber tree," which appears to be a native of China. The Chinese use bark called *Tu-chung*, which is highly valued by them as a medicinal agent, and a specimen of this was collected, amongst other Chinese drugs, by Dr. F. Porter Smith. In making a catalogue of this collection, this specimen attracted the attention of Mr. Holmes, who procured a fresh sample from Hong-Kong and examined it. When broken transversely the bark exhibits a series of white shining silky fibres, which are very extensible ; these are not spiral vessels, for the microscope showed no trace of these organs in the threads. On being placed in a flame a piece flared up and gave off the odour of burning India-rubber. Professor Oliver, the well-known authority at Kew, has examined this bark, and while unable to decide upon the systematic position of the tree from which it is derived, is very plain on one point, which is the only important consideration for electricians, namely, that a quantity of caoutchouc is present in the bark and in all the younger tissues, excepting the wood, properly so called. This tree ought to prove valuable as a source of India-rubber.

Electrical Convection.

IN the *Atti della Reale Accademia dei Lincei* (serie quarta, Rendiconti, t. iv., p. 151), there is a paper by A. Righi, on electrical convection. Here he describes a number of new experiments, and proceeds to consider the results obtained in conjunction with other results which he has previously published upon the same subject of research. Without describing these experiments or following Righi through his method of deduction, we may briefly notice the conclusions which he arrives at. He states that in every case in which there is a loss of electricity, either by an incandescent body or by a point, or by a metal under the action of radiations from the ultra-violet, this loss is due to electrical convection. The moving particles follow approximately the direction of the lines of force of the electric field in which they move. When the air is rarefied to a greater or less degree, the trajectories of these moving particles appear to diverge more and more from the direction of the lines of force ; and in the case where the rarefaction is carried to an extreme degree, these trajectories become almost rectilinear, as appears to be the case with the particles of radiant matter in Crookes's tubes. Righi states that he is making experiments in order to discover whether this gradual transition from one extreme form of the phenomenon to the other, really does take place.

Argumentum ad Judicium.

THE Institution of Electrical Engineers would appear from its proceedings last Thursday, to have reached its anecdotage. The discussion on Mr. Esson's important paper on multipolar dynamos dragged itself along with the greatest difficulty for about half-an-hour and finally expired ; but when an opportunity was afforded to the learned members, by Major Cardew's paper, of relating their personal experiences of "shocks" from high tension currents, the debate became so lively and prolonged that it could only be stopped by the cloture. Whether the subject was the number of milli-ampères that could be passed through Dr. Fleming's head without immediate injury, or the fate of Mr. Mordey's cat, the members appeared to be equally interested ; but we should be glad to find the discussion always as vigorous and spontaneous when subjects of more vital importance to the profession are before the Institution. We may add that Major Cardew's paper is not yet printed, although the authorised abstract of the discussion upon it has been sent to us.

Concentric Wiring.

WE understand that at a recent meeting of the Fire Offices Committee, Andrews's system of concentric wiring for interiors occupied a considerable amount of attention and discussion. It appears that Messrs. J. D. F. Andrews & Co. have recently obtained a contract for lighting the large grain warehouses in Liverpool, in which all insurance offices are more or less interested, or are likely to be at some time or another, and the fire offices appeared much concerned at the introduction of a new system of electric lighting, and discussed it for a considerable time, with the result that the majority proved to be against the new system. A letter was consequently written to the Mersey Dock Board, giving expression to the disapproval and corresponding advice. We have heard that the leading opponent to the system at the meeting, was the representative of the Phœnix Fire Office, while judging from a letter (which we reproduce in our correspondence columns) to the editor of the *Post Magazine*, from the pen of Mr. H. Human, chief surveyor of the Guardian Office, we should suppose that this officer was one of the leaders, if not the leader, in favour of the system. Mr. Human's letter shows him to have able judgment in electrical matters, especially when they relate to the interests of his own business. Although not entirely concurring with all the expressions of Mr. Human, we believe that insurance offices are decidedly at fault in putting any obstacle in the way of the introduction of the system, unless there are more serious objections to its employment than have yet been put forward. Probably some of those firms who contract to do interior wiring might like to express their views on the subject ?

"DIFFERENCE OF ELECTRICAL POTENTIAL" AND "ELECTROMOTIVE FORCE."

WE reproduce the following letter written by Prof. Anthony from the American *Modern Light and Heat* :—

"I have just read an article by Messrs. Sever and Stuart in your issue of March 21st, in which, if I understand the authors, they have fallen into the error of taking the energy required to charge a body as the measure of its potential. The fundamental definition of the measure of difference of electrical potential between two points is 'the work that must be done upon a small body charged with the unit quantity of electricity to move it against the electrical forces from one point to the other.' This is upon the supposition always that the movement of the small charged body does not alter the potential difference which it is desired to measure. In the same way, if the unit quantity of electricity is moved along a *perfect* conductor against electrical forces, the work done upon it measures the difference of potential. Similarly, if the unit quantity is moved *by* electrical forces from one point to another, the work done by it measures the difference of potential between those points, supposing as before that the flow does not change the potential difference. It follows if a body charged with quantity, q, to potential, e, be discharged, that is allowed to fall to 0 potential, the work done is the quantity, q, multiplied by the *average* potential, or $w = q \times \frac{e}{2}$; and since the quantity of electricity required to charge a body to a given potential is proportioned to its *capacity*, $q = e\,c$ (c = capacity), and $w = \frac{e^2}{2} \times c$, that is, the work done when different bodies of the same potential are discharged, or the energy required to charge different bodies to the same potential, is proportional to their capacities.

"When a conductor connects two bodies of a different potential, or when two parts of the same conductor differ in potential, electricity flows, or tends to flow, from the higher to the lower potential, and the tendency is proportional to the potential difference. Potential difference is then *electromotive force*. But very often electricity is compelled to flow *against* electric forces from points of low to points of higher potential. The cause of flow is still *electromotive force*, but it is not difference of electrical potential. This electromotive force is, however, measured in the same units as difference of potential. In fact it is measured by the difference of potential that would balance it. There is always somewhere in any circuit in which an electric current continuously flows an electromotive force acting to carry electricity from a lower to a higher potential.

"All this may be illustrated by reference to gravity potential. Take the surface of the earth as zero, the gravity potential of any point is measured by the work that must be done on the unit mass of matter to carry it from the earth's surface to the point in question. It is *proportional* to the difference of level, but is not *measured* by it. Suppose a reservoir of water at the higher level, and let the reservoir be connected to the surface of the earth by a pipe. Water flows through the pipe in consequence of a *water-moving force* proportional to, and which may be measured by, the difference of gravity potential. But we can put a pump in that pipe and force the water against the force of gravity, from the lower to the higher potential. That pump supplies a *water-moving force*, which is measured by the difference of gravity potential which it may maintain. There is no difference, so far as the resulting energy is concerned, between gravity potential as a water-moving force, and any other water-moving force. They differ only in the direction of the resulting flow. Producing similar results, they should be measured in the same units. So with electrical difference of potential and electromotive force. Both cause electricity to flow ; both are measured in the same units. Potential difference *is* an electromotive force. It differs from other electromotive forces in producing a flow from higher to lower potentials only.

"Let the armature of a dynamo revolve. *Something* causes a flow of electricity through the armature wires from the negative to the positive brush. If the circuit outside the armature is open this flow soon ceases, the E.M.F. in the armature wires being balanced by the potential difference at the brushes. This potential difference measures the E.M.F. in the armature wires. Connect the brushes through some outside circuit ; a current flows in consequence of the difference of potential between the brushes, and this difference of potential is the E.M.F. acting in the outside circuit. But this potential difference is less than it was before the outside circuit was closed, and less than the E.M.F. of the machine, because a part of the E.M.F. of the machine is needed to maintain the flow through the armature wires.

"Suppose the E.M.F. of the machine to be 10 volts and the armature resistance one-tenth ohm, while the external circuit is open the potential difference between the brushes is 10 volts. Close the external circuit through a resistance such that the flow is 10 amperes. To maintain this flow through the armature resistance of one-tenth ohm requires an E.M.F. of one volt, and the potential difference between the brushes must fall to 9 volts, and 9 volts is the E.M.F. acting in the outside circuit."

ABSOLUTE UNITS OF MEASUREMENT.

BY W. MOON.

THE name of absolute units has been given to those systems of units of measurement that are founded upon standards that exist in nature and are invariable.

Thus, the metrical system is founded upon the metre, the 10^{-7} of a quadrant of the meridian, and the second or the $\frac{1}{86400}$th of the mean solar day. As neither the size of the earth nor the length of the day is likely to vary from their present value by any measurable quantity for thousands of years to come, the metrical system is practically one founded upon invariable standards.

Maxwell has pointed out that the most universal standards of length and time are the length of a well defined ray of the spectrum and the periodic time of its vibration. The length of a light undulation of 10^{-6} metres is in the ultra-red spectrum, while the undulation that takes 10^{-15} of a second is in the ultra-violet portion of the spectrum. It is unfortunate that neither of these values is in a visible nor well defined portion of the spectrum.

Besides it being possible to found a system of units upon standards of length and time, it is possible to found such a system upon the velocity of light and the force of gravitation, two standards that are universal. A globe of the same density as the earth and $30{\cdot}6 \times 10^6$ its diameter would have a gravitational accelerative force at its surface equal to the velocity of light, but such a globe would have a diameter greater than the whole solar system, and no such mass of matter in one body probably exists in the universe. But this mass of matter for astronomical purposes is not more ridiculously large than the C.G.S. astronomical unit of mass is small. The C.G.S. unit of mass is that mass which produces unit acceleration at one centimetre distance from its centre. 15·37 tonnes is the mass that would produce this acceleration if it could be squeezed into one centimetre of space.

The kinetic energy of one degree of heat in unit mass of water, or the latent heat of unit mass of water, might be taken as the unit of work ; and the unit of time determined from it and the unit of length, or the unit length determined from the units of time and work.

Owing to the great velocity of light, it cannot well be taken as a unit velocity, and the electrostatic and electromagnetic units made equal to each other. But by selecting suitable units of length and time, the constant v might be made an even power of 10, and at the same time the accelerative force of gravity made equal to unity. If, for instance, the unit of length were $\frac{1}{10}$th decimetre, and the unit of time $\frac{1}{10}$th of a second, the velocity of light would be 10^8 nearly, and the value of g ·98 nearly.

It is unfortunate that g is about 2 per cent. greater than an integer power of 10. It would, however, be very inconvenient to alter its value now by as great an amount as 2 per cent.

It is also unfortunate that the unit of time was taken as the $\frac{1}{86400}$th of the day, instead of some decimal sub-muitiple of the length of the day. To change its value now to some decimal value would, however, entirely upset the whole system of electrical units, and the only practical improvement that it seems possible to make in the arrangement of the time unit

is to divide the hour into 36 divisions of 100 seconds each. This would be a convenient alteration for many purposes.

Although it is convenient to so select the fundamental units that as many as possible of the physical constants shall be equal to unity or of as convenient dimensions or as easily remembered values as possible, yet the fundamental units of length and mass should be taken from man himself; that is those measures of length and mass should be selected from units that are most frequently used. The unit of time, being a less important value, can be selected to make the unit of force as nearly equal to the weight of unit mass as possible.

The Metrical System.

Since the introduction by the French people of the metrical system of measurement, many other nations have adopted this system as its legal measures, and it has been adopted by electrical engineers all over the world as the only rational system on which to found their electrical units.

Ultimately there is no doubt that the metrical system of weights and measures will displace all other systems. But it is to be wondered that electricians and others who understand the system do not take steps to advocate its general introduction for purposes of trade.

Electricians at first adopted the metre and gramme for their units of length and mass. The subsequent change from the M.G.S. to the C.G.S. system was an improvement as far as it made the units of mass and length more nearly related, but it had the disadvantage of making the already small mechanical units smaller still.

And the introduction of *practical* units of force, energy, and power to meet the demands of electric lighting engineers, has resulted in there being two systems of units connected with each other by arbitrary constants.

It is now evident that the metrical units require a re-arrangement by which the practical and theoretical units would have the same value, and in which any multiples or sub-multiples of the fundamental units would be indicated by the prefix to the name of the unit.

By the aid of the dimensional co-efficients it is easy to proceed from one set of metrical units to another, and the calculations are further simplified if the value, M, is taken equal to L^3, that is if the unit of mass is taken in both sets of units as equal to the unit volume of water.

Of all the systems of units that may be formed by varying L and T by multiples and sub-multiples of 10, that system founded on the decimetre kilogramme and decisecond seems to be the best.

If the name "Instant" were given to the 10^{-1} second, the system could be spoken of as the D.K.I. system.

	Dimensional co-efficient.	$L^3 = M$.	Number of C.G.S. units in a D.K.I. unit.	
Velocity	$L T^{-1}$	$L T^{-1}$	10^2	Metre per second $g = \cdot 981$
Acceleration ...	$L T^{-2}$	$L T^{-2}$	10^3	
Work	$L^2 M T^{-2}$	$L^5 T^{-2}$	10^7	= Joule
Kinetic energy ...				
Moment of couple				
Force	$L M T^{-2}$	$L^4 T^2$	10^6	g^{-1} kilogrammes
Power	$L^2 M T^{-3}$	$L^5 T^{-3}$	10^8	= 10 watts
Pressure	$L^{-1} M T^{-2}$	$L^3 T^{-2}$	10^4	= g^{-1} kilogrammes per sq. decimetre
Momentum ...	$L M T^{-1}$	$L^4 T^{-1}$	10^5	

The length of a decimetre, which is the size of the palm of one's hand, is a more convenient unit of length than the centimetre, and the tenth of a second is a duration of time that can be easily conceived, many watches being fitted with a hand to indicate the tenths of a second.

The velocity of a decimetre an instant is a metre a second, or about a slow rate of walking, and is a much more rational unit of velocity than a hundredth of that value.

The unit of acceleration of $\frac{\text{decimetre}}{\text{instant}^2}$ gives a value of $g = \cdot 98$, that is g is nearly equal to unity. The kilogramme is a more convenient unit of weight than any of the other metrical weights.

Since the value of $g = \cdot 98$, the D.K.I. unit of force would be but 2 per cent. more than the weight of a kilogramme, so that the weight of a kilogramme could be taken as the unit of force for rough calculations.

A pressure of $\frac{1}{g}$ kilogrammes per square decimetre would be a perfectly intelligible unit, and the atmosphere of 101·4 such units might be taken as 100 kilogrammes to the square decimeter for rough calculations.

The name Barie, which has been proposed for the pressure of an atmosphere, might be better given to the D.K.I. unit.

The D.K.I. unit of work, would be exactly equal to the present Joule or nearly a kilogramme × decimetre, that is to nearly ·7 foot pounds.

The D.K.I. unit of power would be equal to 10 watts, so that the C.G.S. kilowatt would become a D.K.I. hectowatt.

The advantage of taking the decimetre kilogramme and decisecond as the fundamental units will be at once seen by comparing the preceding values with the corresponding ridiculously small C.G.S. values of the units.

In the C.G.S. system, both the centimetre and the gramme are much too small. The gramme which is less than $\frac{1}{28}$th part of the English ounce, is a weight only of use to chemists and the like, while the centimetre is too short a length to be used for ordinary purposes of trade.

One can form no conception of the value of the dyne, the $\frac{1}{981000}$th of the weight of a kilogramme. But if the weight of a kilogramme were the unit of force, by holding up a kilogramme we could form a very clear conception as to its value. Similarly, by lifting a kilogramme through a decimetre, we perform about ·74 foot pounds of work, a quantity that is easy to conceive. But of the erg, which is $\frac{1}{9810000}$th of the kilogrammedecimetre, we can form no conception.

Had the kilogramme, which is the weight most generally used for ordinary purposes of trade been taken as the fundamental unit of weight, it would be not only more easy to form a conception of the values of the derived units, but those derived units themselves would not be so absurdly small as with the C.G.S. system.

The changing of the value of the fundamental units of length, mass and time does not, of course, necessitate any change in the derived practical electrical units of E.M.F. current and resistance. These units could still remain awkward multiples of the derived theoretical units, as at present.

It would, however, greatly simplify the system to alter the practical units and so name them that their value in absolute units should be at once indicated by their name.

	Dimensional co-efficient	$M = L^3$	No. of C.G.S. units in D.K.I. unit.	Number of C.G.S. practical units in a D.K.I. unit.
Strength of pole ...				
Quantity of magnetism	$L^{\frac{5}{2}} M^{\frac{1}{2}} T^{-1}$	$L^3 T^{-1}$	10^4	
Flux of force ...				
Moment of magnet	$L^{\frac{5}{2}} M^{\frac{1}{2}} T^{-1}$	$L^4 T^{-1}$	10^5	
Intensity of field or of magnetisation	$L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1}$	$L T^{-1}$	10^2	
Magnetic induction				
Magnetic potential	$L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-1}$	$L^2 T^{-1}$	10^3	= 10^4 ampères.
current				
Quantity	$L^{\frac{3}{2}} M^{\frac{1}{2}}$	L^2	10^2	= 10^3 coulombs.
E.M.F.	$L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-2}$	$L^3 T^{-2}$	10^5	= 10^{-8} volts.
P.D....				
Resistance	$L T^{-1}$	$L T^{-1}$	10^2	= 10^{-7} ohms = 10^{-1} microhm.
Specific Resistance	$L^2 T^{-1}$	$L^2 T^{-1}$	10^5	Microhms per cubic centim.
Inductance... ...	L	L	10	
Capacity	$L^{-1} T^2$	$L^{-1} T^2$	10^{-3}	10^{12} microfarad.
Current density ...	$L^{-\frac{3}{2}} M^{\frac{1}{2}} T^{-1}$	T^{-1}	10	645 amps. to sq. in. 1 amp. to sq. millim.
Electric induction...	$L^{-\frac{3}{2}} M^{\frac{1}{2}}$	1	1	
Electric force at point	$L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-2}$	$L^2 T^{-2}$	10^4	
Calorie	L^3	L^3	10^3	= 4,200 joules.

The derived D.K.I. electrical units are of a more convenient value than the C.G.S. ones. Thus the D.K.I. hectovolt corresponds to the C.G.S. volt, while the D.K.I. megvolt would be convenient to expresss high E.M.Fs.

The E.M.F. of cells in D.K.I. units would occupy three places of figures, a convenient number, since no cell can in

practice be relied upon to a greater accuracy than $\frac{1}{100}$th part.

The D.K.I. unit of current is an amount quite within the output of a central electric lighting station, and if electric lighting engineers spoke of the current supplied to individual lamps as so many milliampères and telegraphists spoke of so many microampères, no confusion would in either case result between the D.K.I. and C.G.S. units; although the D.K.I. milliampère and microampère are respectively ten times the C.G.S. ampère and milliampère in value.

The D.K.I. unit of current density is a current density very frequently used in practice.

The greatest difficulty in changing from the C.G.S. to the D.K.I. units would be in the unit of resistance, since all the resistance coils would require remarking. If, however, the D.K.I. unit of resistance were called the ohm, the D.K.I. megohm would be $\frac{1}{10}$th of the C.G.S. ohm, and could not well be confused either with the C.G.S. ohm or megohm. A further multiple of the D.K.I. unit to express insulation resistances could be obtained by calling the D.K.I. ohm $\times 10^{12}$ the omegohm. This unit would be equal to $\frac{1}{10}$th of the C.G.S. megohm.

With the ever growing tendency in the use of smaller resistances for electric lighting purposes, the retaining of the simpler name of ohm for the absolute unit of resistance must ultimately prove of advantage.

The unit of inductance could, after the more expressive manner of Ayrton and Perry, be called the insohm, so that the megainsohm would be equal to $\frac{1}{10}$th of the secohm or quad.

The specific resistance in the D.K.I. system would be expressed in exactly the same figures as microhms per cubic centimetre in the C.G.S. system.

The electrochemical equivalent in both the C.G.S. and D.K.I. systems is the same.

The D.K.I. unit of capacity would equal 10^{12} C.G.S. microfarads, and the C.G.S. microfarad could be renamed the omicrofarad to express the power 10^{-12}.

In the D.K.I. system the intensity of magnetism of steel magnets would be between 1 and 2 so that the magnetic moment of steel magnets would be between 1 and 2 times their volume; also, in the D.K.I. system the number of lines of induction through iron would be expressed in two or three places of figures. Thus the pull, or portative force, in D.K.I. units with $B = 74$ and $B = 198$ would be 221 and 1,590 kilogrammes per square decimetre, or 225 and 1,620 Baries respectively. The unit "Barie" being equally able to express a pressure or a pull per unit of surface.

The energy expended in joules for one cycle of magnetism of $B = 38$ and $B = 156$ would be ·116 and 1· joules respectively per cubic decimetre of iron.

It is unfortunate that the electro-magnetic system of units was founded upon the force between two poles at unit distance instead of upon the pull of two unit lines of induction at right angles to each other, since with the present system the unit intensity of magnetisation is 4π times the unit intensity of field and of the unit line of induction.

Had the force between two unit lines of induction at right angles to each other been taken equal to the unit of force, then the pull across unit area of B lines of induction would have been $\frac{B^2}{2}$ instead of $\frac{B^2}{8\pi}$ as at present. The magnetising force of a long helix of wire would be equal to the current turns per unit of length of the helix instead of to 4π that number, and it would require two turns of wire at unit distance, carrying unit current, in a tangent galvanometer to produce a deflection of 45° in unit field instead of $\frac{1}{2\pi}$ turns as at present.

Thus the use of the constant, π, would be avoided in three different operations only to be introduced in one, namely, the action of magnets upon each other at a distance; a measurement which is not now of so much importance as formerly.

To make this change now would, however, upset the value of most of the present electrical units, and cause considerable confusion for a time. For not only would the unit line of induction and the intensity of field be increased $\sqrt{4\pi}$ times, and the unit intensity of magnetisation be $\frac{1}{\sqrt{4\pi}}$ its present value, but the unit of resistance would be increased 4π times, and the unit of E.M.F. $\sqrt{4\pi}$ times, while the units of current and quantity would be $\frac{1}{\sqrt{4\pi}}$ times, and the unit of capacity $\frac{1}{4\pi}$ times their present value.

Since intensity of magnetisation can be always expressed in lines of induction, it is unnecessary to apply a separate name to this unit.

The unit intensity of field and of magnetic induction could be well named the Gauss, while the unit of magnetic moment could be called the Weber. A number of lines of induction irrespective of the area they pass through, that is a flux of force, could be spoken of simply as so many lines of induction.

A glance at the following tables will show that of all the metrical systems of units that the D.K.I. system is the best. In none of the others are the units of acceleration force and work of such a convenient value. And in all of them the electrical units of E.M.F. current and resistance are not any more convenient for practical use than those of the D.K.I. system. And none but the D.K.I. system is founded upon primary units of the most commonly used values, and values that can be easily conceived.

It is strange that scientists make such little effort to introduce the metrical system for ordinary purposes of trade.

The transition from the English to the French system of weights and measures would not be difficult. If an Act of

		No of C.G.S. units.	Metre tonne second.	No of C.G.S units.	Centimetre gramme centisecond.	No. of C.G.S. units.	Centimetre gramme 10^{-9} second.	No. of C.G.S. units.	Millimetre milligramme 10^{-10} second.	No. of C.G.S. units.	$L = 10^{-4}$ $T = 10^{-14}$ Length of ray of ultra-red light, and time of ultra-red vibration × 9·004.
Velocity	$L\,T^{-1}$	10^2	metre per sec.	10^2	metre per sec.	10^9	10^9 centims. per sec.	10^9	10^9 centims. per sec.	10^{10}	... ...
Acceleration	$L\,T^{-2}$	10^2	g = 9·81	10^4	g = ·0981	10^{18}	$g = 981 \times 10^{-15}$	10^{18}	... ...	10^{24}	... ...
Force	$L^4\,T^{-2}$	10^8	... ...	10^4	... ...	10^{18}	... ...	10^{16}	... ...	10^{12}	... ...
Work	$L^5\,T^{-2}$	10^{10}	10^3 joules	10^4	10^{-3} joules	10^{18}	10^{11} joules ...	10^{15}	10^5 joules ...	10^8	10 joules
Power	$L^5\,T^{-3}$	10^{10}	10^3 watts	10^6	10^{-1} watts	10^{27}	10^{20} watts ...	10^{25}	10^{18} watts ...	10^{22}	10^{15} watts
Pressure	$L^2\,T^{-2}$	10^4	... ...	10^4	... ...	10^{18}	... ...	10^{18}	... ...	10^{30}	... ...
Momentum	$L^4\,T^{-1}$	10^8	... ...	10^2	... ...	10^9	... ...	10^6	... ...	10^{-2}	... ...
Quantity magnetism	$L^3\,T^{-1}$	10^6	... ...	10^2	... ...	10^9	... ...	10^7	... ...	10^2	... ...
Moment magnet ...	$L^4\,T^{-1}$	10^8	... ...	10^2	... ...	10^9	... ...	10^6	... ...	10^{-2}	... ...
Current...	$L^2\,T^{-1}$	10^4	10^2 ampères	10^2	10^1 ampères	10^9	10^{10} ampères ...	10^8	10^9 ampères ...	10^6	10^7 ampères
Quantity	L^2	10^4	... ...	1	... ...	1	... ...	10^{-2}	... ...	10^{-8}	... ...
E.M.F.	$L^3\,T^{-2}$	10^6	... ...	10^4	... ...	10^{18}	... ...	10^{17}	... ...	10^{16}	... ...
Resistance	$L\,T^{-1}$	10^2	10^{-7} ohms	10^2	10^{-7} ohms	10^9	1 ohm	10^9	1 ohm	10^{10}	10 ohms
Specific resistance ...	$L^2\,T^{-1}$	10^4	... ...	10^2	... ...	10^9	... ...	10^8	... ...	10^6	... ...
Inductance	L	10^2	... ...	1	... ...	1	... ...	10^{-1}	... ...	10^{-4}	... ...
Capacity	$L^{-1}\,T^2$	10^{-2}	10^{13} microfarad	10^{-4}	10^{11} microfarad	10^{-18}	10^{-3} microfarad	10^{-21}	10^{-6} microfarad	10^{-32}	... ...
Current density ...	T^{-1}	1	... ...	10^2	... ...	10^9	... ...	10^{10}	... ...	10^{14}	... ...
Electric induction ...	1	1	... ...	1	... ...	1	... ...	1	... ...	1	... ...
Electric force at point	$L^3\,T^{-2}$	10^4	... ...	10^4	... ...	10^{18}	... ...	10^{18}	... ...	10^{30}	... ...
Intensity of field ...	$L\,T^{-1}$	10^2	... ...	10^2	... ...	10^9	... ...	10^9	... ...	10^{10}	... ...
Calorie	L^3	10^6	... ...	1	... ...	1	... ...	10^{-3}	... ...	10^{-12}	... ...

Parliament were passed making it compulsory to mark all graded liquid measures and measures of length in both systems, or in the French system only. Then after a certain time had elapsed and the measures marked in the English system only had worn out, the marking of such measures in the French system only could be made compulsory. Of course, the greatest difficulty would be experienced in altering the present weights to the metrical ones, as most of the present weights would have to be entirely discarded. Liquid measures not graded could, of course, be cut down to size in many cases.

There are certain measures of capacity and weight, such as sacks, barrels, &c., which are very ridiculous multiples of the standard measures of capacity and weight. But by a little pressure all such measures could be made to be at least rational and easily recognisable multiples of the standard measures of capacity or weight.

It would be even more easy still to change our present system of money to a decimal system. All our present gold and silver coins can be expressed in a decimal system of florins and cents, except the 3d. It would, therefore, be only necessary to stamp all gold and silver coins issued in future with both their present values and their values in florins and cents. Then in a few years' time, after the people were well accustomed to the values of the coins in the decimal system, to recoin all the copper money in cents, and from that date to mark the gold and silver coins in the decimal system only.

At the same time it would be necessary to make the teaching of the metrical system in our schools compulsory, and to make all scientific books publish their figures in either the metrical system alone or in both the English and the French systems, and, after a certain number of years, in the French system alone.

WHAT ARE THE LIMITS OF HIGH POTENTIAL TRANSMISSION?

IN a letter appearing in the *Elektrotechnische Zeitschrift*, August Schneller, of The Hague, Holland, draws attention to certain points, which, he claims, have not been fully considered. He writes as follows:

"In our technical papers the power transmission project from Lauffen to Frankfort, on the occasion of the Frankfort Exhibition, has been the frequent object of discussion of late. Although in the carrying out of my experiments in the preparation of ozone, I have already had considerable experience with alternating currents up to 24,000 volts potential, I have up to now avoided taking part in this discussion. Since, however, this project has been seriously taken up and spoken of by his Excellency, Dr. Von Stephan, I have regarded it as my duty to testify to the enormous difficulties of transmitting power with 20,000 volts alternating current, which make its carrying out in practice impossible. The transmitted 300 H.P. may have at the primary transformer 30,000 volts and 6·2 ampères = 186,000 watts. To obtain 30,000 volts by transformation in commercially practicable apparatus, so as to be safe, is indeed difficult, but under certain construction not impossible.

"The chief difficulty in the transmission of 30,000 volts lies not, however, in the fourfold transformation, and the loss thereby entailed, nor in the transformers themselves, but in the outside conductors. With 6·2 ampères, with a copper wire of 5 mm. diameter, and with 350 kilometres of wire, the drop in potential amounts to only 1,830 volts = 6·1 per cent.; but the other losses which the conductors are subject to have been entirely left out of account up to the present. For the overhead conductors telegraph poles are necessary, which ought not to be more than 50 metres apart, so that altogether there will be 3,500 telegraph poles, and 7,000 oil insulators. One insulator, even an oil insulator, has an average resistance of 1,000 megohms when measured with low potential battery current. For 7,000 insulators there may then be a resistance of 150,000 ohms; then there would be, at 30,000 volts, 0·2 ampère loss, which loss of 3·2 per cent., in such an important undertaking, may almost be neglected.

"Now, however, comes the principal point: The 'charging loss,' according to my measurements, for an air dry insulator at 15,000 volts, amount to 2·3 watts; at 20,000 volts to 4·7 watts, and at 30,000 volts might reach about 15 watts. In the 7,000 insulators then, in dry weather, there would be about 100,000 watts loss. The losses in foggy or rainy weather are still left quite out of the calculation. If we assume a distance between the parallel conductors of one metre, there results, at 30,000 volts potential, a loss of 0·15 watt per metre by silent discharge; hence, for 175 kilometres, a loss of 26,000 watts. Allowing an efficiency of 95 per cent. for the primary and secondary machines, and 98 per cent. for the transformers at full load, the loss in the line 6·1 per cent., the insulation loss 3·2 per cent., the 'charging loss' on the insulators at 100,000 watts, and the silent discharge in 175 kilometres of parallel conductors at 26,000 watts, then we come to the conclusion that in dry weather, from the Lauffen plant of 300 H.P., we will get in Frankfort about 37 H.P.

"There must be taken into account still further about 6,000 square metres of condensing surface of the conductors and insulators. I have measured the sparking distance with 20,000 volts alternating current at 100 reversals per second, without any condenser, and found it to be 46 mm.; and when a condenser of 15 sq. mm. surface was included, the sparking distance was more than 80 mm.; but how great the sparking distance is with 6,000 square metres of condensing surface goes beyond my experience. On the basis of these truths it is easily seen that the whole project is a technical impossibility."

To this Mr. Charles Steinmetz replies as follows in the New York *Electrical Engineer*:—

"In the last number of the *Electrical Engineer*, I noticed Mr. A. Schneller's criticism of the project to transmit 300 H.P. by alternating currents of 30,000 volts pressure over a distance of 115 miles. As Mr. Schneller's rather unfavourable remark, 'technical impossibility,' might perhaps influence the opinion of many engineers against the advisability of power transmission under such pressures, I deem it proper to show the fallacy of Mr. Schneller's conclusions. Of course, everyone will acknowledge that the use of 30,000 volts pressure will bring about difficulties not met with in usual practice, and some experience will have to be gathered, and even partial failures are to be expected, before Niagara Falls water-power will light New York's streets, and drive the shafting in its factories.

"But to come to Mr. Schneller's criticism, it is neither unsafe nor difficult to build reliable transformers for pressures of 30,000 volts and even more, because every large Rhumkorff spark coil generates hundreds of thousands of volts. We must only bear in mind then, that for such pressures air-spaces can no longer be considered as insulators. Hence we have to enclose the whole transforming apparatus in a medium of better insulating qualities, as was done with the oil transformers used in the Oerlikon experiments.

"The leakage current through the oil insulators of the line conductors, is considered even by Mr. Schneller as unimportant. I consider it of still less importance, because I hardly think that Mr. Brown had the best possible oil-insulators for his tests, and so I think that even the 3·2 per cent. loss referred to will be essentially reduced.

"Mr. Schneller considers the charging loss in the oil insulators as the principal one, and calculates an enormous value for it, while the Oerlikon experiments, even when using a pressure higher than 30,000 volts, and a number of insulators equivalent to quite a considerable part of the proposed line between Frankfort and Lauffen, showed no perceptible charging loss. No one, up to the present, in designing insulators, has paid any attention to their static capacity, for the very simple reason that this capacity has thus far been without importance. If condenser capacity of insulators should show any influence in practical working, it will be an easy task to build insulators with the least possible capacity, just as telephone cables are built for least possible capacity, this being essential for their effective working.

"Then Mr. Schneller gives figures of charging losses without giving the number of periods per second employed; but the charging loss is directly proportional to the number of periods, and therefore by reducing the number to, say, one-fourth, it would be decreased by 75 per cent., while generators and transformers of a size fitted for use in such large power transmissions will work just as economically as with higher frequencies, and motors even more economically.

"Furthermore, with regard to the silent discharge which Mr. Schneller charged with a loss of 20,000 watts, everybody who ever handled a static electric machine, for instance a Töpler-Holtz, which gives pressures far in excess of 30,000 volts, know that by simply covering the conductor with an insulator such as India-rubber, the brush discharge from the rubber-covered parts disappears almost entirely.

"Therefore, these two large losses which to Mr. Schneller seem to prove the project a technical impossibility, can exist only in a line improperly built and poorly insulated; but by proper care in the construction, they can be made so small that they may very likely be entirely neglected.

"One word more about the telephone disturbances. These disturbances are proportional to the current flowing in the line, and entirely independent of the pressure, so that a given current always gives the same disturbance, no matter whether it is backed only by a few volts or forced ahead by hundreds of thousands of volts. Therefore every increase of pressure will materially reduce the telephone disturbance by reducing the current needed to transmit the power.

"Therefore I consider a power transmission by means of such a pressure not at all as impracticable, nor 30,000 volts as the highest pressure possible to use, but consider it only as the second step in that direction, the first of which was taken by Ferranti by sending 10,000 volts into his primary mains; and I do not believe in any limit of pressure possible with the alternating current, but, on the contrary, that in the not distant future we shall see power transmissions for long-distance railways, &c., working under a pressure of even hundreds of thousands of volts and working safely and satisfactorily."

LIGHTING THE NEW METROPOLITAN POLICE BUILDINGS.

THE whole of the new Metropolitan Police offices at New Scotland Yard have been fitted with the electric light by Messrs. Drake and Gorham, as contractors, with Mr. A. A. Campbell Swinton as consulting engineer.

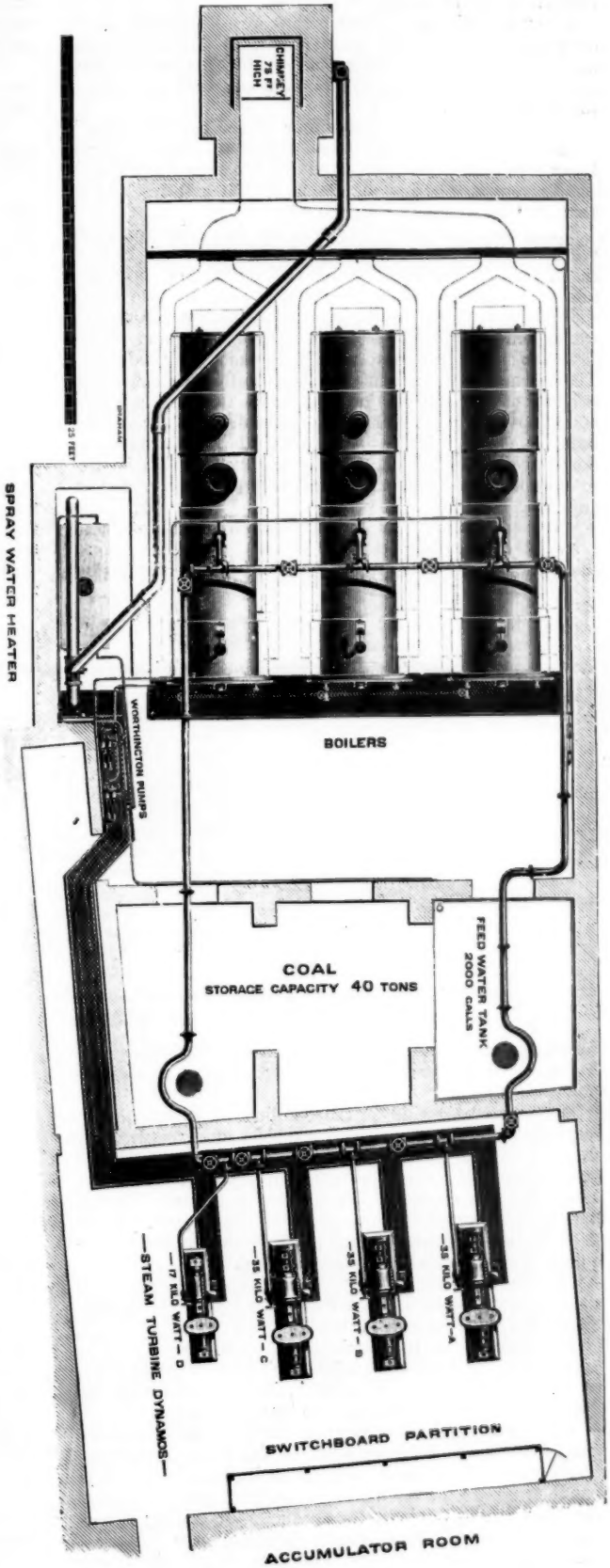
There are about 1,100 lamps at present fixed, and the total number will eventually be about 1,250.

Every effort has been made to render this installation as complete and perfect as possible, and it is believed that every possible contingency which could produce a failure of the light has been provided against and overcome. The enginehouse has been excavated in the yard, between the main building and Whitehall, and the whole of the generating plant has been placed well away from the offices.

The steam plant consists of three "Lancashire" boilers by Davey, Paxman & Co., each 22 feet 6 inches by 6 feet diameter, each containing two flues 2 feet 3 inches diameter, with three circulating tubes, and Paxman's patent strengthening and expansion joint. The heating surface of each boiler is 480 square feet, and the three boilers are capable of evaporating from 6,000 to 8,000 lbs. of water per hour.

The chimney is 12 square feet in sectional area, and is carried up to a height of 80 feet, the bottom 40 feet being lined with fire brick. The steam is conveyed to the engine room by a duplicate system of steam-pipes, divided by nine valves, which enable any length to be cut out of circuit as required, and provides for the continuation of the working in the event of a failure of the steam-pipe at any point.

The feed water heater is of a special type, consisting of a tank, into which the feed water is admitted by a ball valve, the water being blown into a spray by the exhaust steam from the engines, which enters immediately under the ball valve. A by-pass is provided to carry the exhaust direct to the



chimney, and thereby the amount of steam entering the heater can be varied, and the temperature of the water can be regulated from cold to boiling, as required.

Two "Worthington" steam pumps are so arranged as to draw water from the feed water heater, or direct from the main feed water tanks, which contain 2,000 gallons of water, and are so connected that either pump can feed any one of the boilers at will.

The current is obtained from four of the new "Parsons" steam turbines and shunt-wound dynamos, three of these being capable of giving an output of 35 units each, and a smaller generator giving an output of 120 ampères × 130 volts for the charging of accumulators.

These machines differ chiefly from the older forms of "Parsons" generators, in that they run at a lower rate of speed, and the turbines are on the radial flow principle instead of parallel flow, as previously. They are also fitted with a new form of variable expansion electrical governor, which secures additional economy at light loads, and is designed to maintain a constant E.M.F. under all conditions. The accumulators consist of 106 cells, capable of discharging at a rate of 120 ampères for nine hours for the supply of 200 lamps of 16 C.P. each. The main distributing switchboard is placed 2 feet 6 inches from the wall, and doors provide access to the back of the partition, so that all the connections at the back and front can easily be inspected at any time.

The lamp circuits from the main building are brought to a special distributing board fitted with cross connections, and patent ring contact switches, the design permitting both positive and negative connections to be shifted from any one of the sources of generating power to another instantaneously.

The ordinary lighting for the building is supplied direct from the steam turbine dynamos, which supply a perfectly steady light, the extremely sensitive automatic governor keeping the E.M.F. constant within a very small percentage. The battery is charged from the smaller generator during the day, and, except in cases of emergency, is used only for the night service after 10 p.m., and for any few lamps required in dark places during the day time.

The voltmeters are of the "Cardew" pattern, made with specially large dials so that the voltage may be seen at a glance from any point in the engine room.

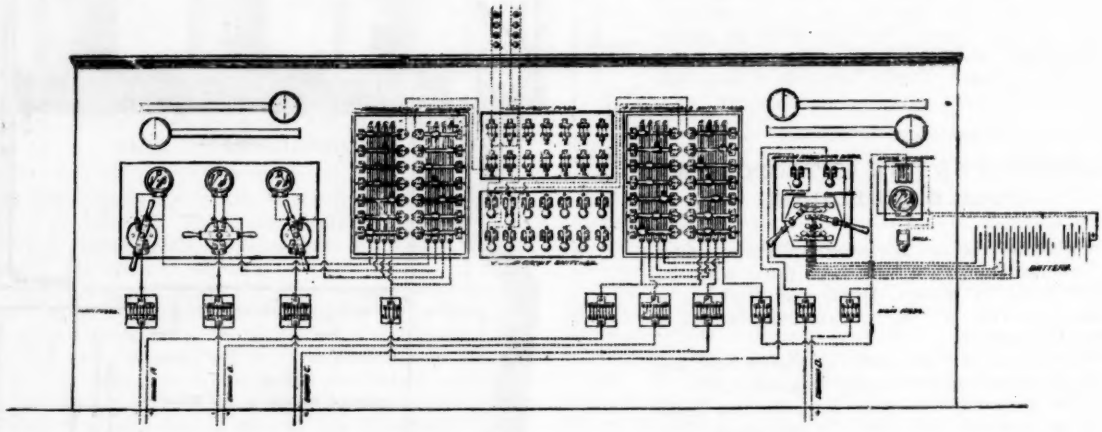
The wiring of the main building has been carried out so as to obtain the greatest security and immunity from failure of the light—a number of small mains being run from the distributing board in preference to large conductors.

Every alternate lamp throughout the building is supplied from a different circuit, so that, in the event of a breakdown, only half the lights would be extinguished. Throughout the passages the casing is let in flush with the face of the plaster, so as to render the conductors accessible without being an eyesore. The branch conductors are carried to small distributing fuse boxes, with glass fronts, placed over the doors in the different offices, from which point special vulcanised twin conductors braided with white cotton are carried to each lamp on the face of the concrete ceilings and supported with eyelets bushed with ebonite. This arrangement enables the position of the light to be shifted at any time without difficulty, and provides one solution of the extremely difficult problem of running the branch wires in modern fireproof buildings in which no lath and plaster is used.

In order to insure economy a separate switch has been provided for every individual lamp throughout the rooms and offices.

The generating plant also provides electrical power to the printing office, where the Police Reports and Notices are now all printed by a machine worked by an electro-motor.

New Scotland Yard is, it is believed, the first Government office lighted entirely and exclusively with the electric light. The whole installation is now practically complete, and the new illuminant is giving general satisfaction to the occupants.



IS CHEMICAL ACTION AFFECTED BY MAGNETISM?

THE close relationship between electricity and chemical affinity on the one hand and that between electricity and magnetism on the other have naturally raised the question whether any relation can be traced between this affinity and magnetism. This question was the subject of numerous investigations during the early part of the century, but seems to have been lost sight of till in 1882, when Prof. Remsen again attracted attention to it by the interesting observation that, from a solution of the sulphate, copper is unequally deposited upon the armature of a horseshoe magnet (*vide American Chemical Journal*, vol. iii., p. 137).

Other experiments have also borne relation to this question, *e.g.*, those of Messrs. Nichols and Franklin (*vide American Journal of Science*, vol. xxxiv., p. 419, and xxxv., p. 290) and of Messrs. Rowland and Bell (*vide Phil. Mag.*, vol. xxvi., p. 105), &c. The subject has recently been approached from a new side by Morris Loeb, who started with the conviction that all of these investigations introduce phenomena which tend to obscure the point at issue, *i.e.*, the effect of magnetism upon the chemical reaction itself.

The earliest experiment dealt with the rusting of bar magnets, and the most trustworthy observers appear to invalidate the assertion of some, namely, that magnetised iron differs from the non-magnetised metal in this respect, or that the north and south poles exhibit dissimilar behaviour. The experiments were naturally crude, and a positive result, were it admitted, would obviously have been due to a polarised arrangement of the molecules rather than to variations in chemical affinity.

Next came the crystallisation of salts or metals from a solution, within and without a magnetic field. A number of observers appear to have found that the direction of growth, either of the crystals themselves or of the clusters which they form, can be affected by the presence of a magnetic field, even though the substance be itself diamagnetic. But what is there in this that involves a modification of chemical action? The quantity of deposit has not been observed to

be altered by the magnet; the physical arrangement of the molecules during crystallisation is always governed by directive forces having no connection with affinity, and to the ordinary ones is now superimposed the polarising influence of the magnet.

A different principle is involved in Remsen's experiments, for they depend upon the removal of particles from a magnetised mass of iron and the substitution for them of slightly magnetic copper. The explanation of Messrs. Rowland and Bell must appear highly plausible, that the resistance to such removal must protect the more highly magnetised points from reaction, so long as there are places where the iron can be more readily dissolved. We have here a purely mechanical reason for the localisation of the reaction in a non-uniform field. That the *total* amount of reaction would not be affected we may infer from an experiment by Fossati (*vide* Wiedemann's *Beiblätter*, 1890, p. 1,010), in which he shows that the weight of iron precipitated from a solution by zinc is not affected by the presence of a strong magnetic field.

Apparently inconsistent with the "protection" hypothesis are the observations of Messrs. Nichols and Franklin, which show that iron which has become "passive" through the action of strong nitric acid, suddenly regains its activity when introduced into a magnetic field. One might be tempted to ascribe this to the exposure of fresh surfaces, owing to the rearrangement of the molecules during magnetisation; but since the investigators have reason to seek the cause in the induction of local electric currents by the magnet, we may assign this phenomenon to the galvanic action in the magnetic field.

Messrs. Nichols and Franklin appear to have been the first to experiment upon the effect of an unequal magnetic field upon an electrolyte; the movement of the para-magnetic salt to the interior portions of the field, and the inequality of electric potential consequent upon the variation of concentration, were proved as might be expected. We have, then, this effect, as well as that of the induction of Faraday, to account for any irregularities which the galvanoscope might indicate when a solution undergoing electrolysis is also subjected to magnetic influence. Messrs. Nichols and Franklin do ascribe their observations to this cause, and see no reason to introduce a supposed change of chemical conditions.

Mr. Loeb fails to see any significance in the experiment of placing one of two gas-voltameters or one of two cells containing an iron solution in a magnetic field, as performed by Fossati, and then looking for a difference in the amount of decomposition when a current is passed through the couple in series. Surely no such result, he says, could be expected in the face of the universally-acknowledged law of Faraday, unless, indeed, a magnetic field were imagined to alter the quantivalence of the elements.

To sum up, all experiments hitherto made have introduced non-chemical phenomena, due either to the inequalities of the magnetic field or to the physical heterogeneity of the reacting system, or to both of these causes at once. Mr. Loeb starts with the idea of studying the effect of magnetism upon chemical reaction when the system remained homogeneous throughout, and when the field of stress is practically homogeneous. Such conditions can be realised by observing the speed of some reaction which does not involve solids in the presence of a magnet, and again when there is no magnetic effect, provided the magnetic properties of the system could be altered by the reaction. In the same manner as an electric system is affected by its approach to or removal from a magnetic field, we might suppose that a reaction which made a system more or less amenable to magnetic action, might show evidence of acceleration or retardation by the magnetic force. If this effect were appreciable the relation between magnetic force and chemical affinity would be established, and data could be obtained for calculating the real value of magnetisation.

Mr. Loeb undertook the investigation of this question. The choice of materials was rather limited: of all compounds the salts of the iron group alone yielded markedly para-magnetic solutions; further, Wiedemann has shown that the ordinary forms of reaction between salts does not affect the total magnetism of the system so long as it involves merely an interchange of acids. But there is a marked change when the constitution of one of the ingredients is altered; the atomic magnetism of trivalent iron is 25 per cent. greater than that of the same element in the former state. Hence Loeb decided to study the effect of magnetism upon the speed of oxidation and reduction of iron salts in solution by reagents which showed but a feeble magnetism by themselves.

Two such reactions have already been studied under ordinary conditions, and, inasmuch as the methods employed seemed admirably suited to the investigation which Loeb undertook, he adopted them. These methods are those of J. J. Hood (*vide Phil. Mag.*, series (5), vol. vi., p. 371: vol. viii., p. 121, and vol. xiii., p. 419) and Meyerhoffer (*vide Zeitschrift Phys. Chem.*, vol. ii., p. 597).

A large Rhumkorff electro-magnet with cylindrical iron cores 10 inches long and 3 inches thick was used. The poles were 3 inches apart, and a current was employed from ten storage cells, the intensity of the magnetic field being roughly determined at 10,000 C.G.S. units per square cm. A prismatic battery cell $2\frac{1}{2} \times 6 \times 6$ inches was placed between the poles to serve as a bath of constant temperature, and was protected from direct contact with the poles by thin layers of cotton and was traversed by a rapid current of water, whose temperature was kept within 0·1° C. of the desired temperature. The solutions were placed in a flat flask, and this was suspended just between the poles of the magnet.

So much for the apparatus: the methods of examination were of a strictly chemical nature, and the actual numerical results obtained would occupy more space than we can conveniently afford. Those of our readers who are sufficiently interested to follow out the experiments made by Loeb on the oxidation of a ferrous salt, and the reduction of ferric chloride, are referred to the American *Journal of Chemistry*, vol. xiii., No. 3, pp. 145—153, where they will find every detail they require.

The majority of our readers will chiefly be interested in the conclusions drawn from the results of this investigation. It seems that the results obtained were *negative*. It might, perhaps, be suggested that the means of observation at disposal were inadequate; but this, we believe, was not the case. Loeb is confident that his method is of no lower order of delicacy than those hitherto employed in connection with the subject, and looking at the results, such as they are, he does not hesitate to assert his opinion that no relation between magnetic force and chemical affinity can be established.

NOTE ON THE AGREEMENT BETWEEN THE ELECTRO-MAGNETIC UNIT AND THE ELECTROSTATIC UNIT OF ELECTRICITY.

By H. PELLAT.*

THE agreement which exists between the electro-magnetic unit and the electrostatic unit of electricity is easily demonstrated, since the number which expresses a difference of potential in electro-magnetic units is the same as that which expresses it in electrostatic units.

In virtue of the relation discovered by Ohm, namely,

$$\varepsilon = i\,r,$$

the absolute measurement in electro-magnetic units has been brought to the absolute measurement of a resistance, r, and that of a current, i.

The measurement of i has been effected by my absolute electro-dynamometer (*vide Comptes Rendus*, ciii., p. 1,189; 1886).

For the measurement of the resistance, I have assumed that the true ohm is $\frac{106{\cdot}3}{106}$ of the legal ohm. Finally, the measurement in electrostatic units has been effected by means of the absolute electrometer of Sir William Thomson. Here is a description of the method employed.

The current was yielded by a battery, A, composed of several sets of cells: the battery possessed a total resistance, R, made up of n equal resistances, $R^1 = 100{,}000^{\omega}$.

The difference of potential at the ends of one of these

* Read before the Paris Academy of Science, April 13th, 1891.

resistances, R¹, was opposed to the electromotive force of a battery, B, consisting of thirteen Latimer Clark cells. Compensation, the value of which was observed by means of a capillary electrometer, was produced and maintained exactly by adding or subtracting by the aid of a convenient commutator the necessary number of cells. This operation ensured the constancy of the current from the battery, A, while the measurements were being taken.

The difference of potential at the ends of the resistance, R, which was measured by means of the Thomson electrometer, was exactly n times the electromotive force, E, of the battery, B.

In order to obtain E, the thirteen elements in the battery, B, were compared by the method of opposition with a standard Latimer Clark cell, T, which was furnished with a thermometer.

The electromotive force of the cell, T, calculated with reference to its temperature in each experiment, was determined in absolute values from time to time, according to the following plan :—

The element, T, was opposed to the difference of potential produced at the end of a resistance, r, by the passage of a current, i, measured by means of an absolute electro-dynamometer; the compensation, observed by means of a very delicate capillary electrometer, was obtained and maintained by means of a rheostat placed in the circuit of the current, i; this operation ensured the constancy of the current, i, during the measurement by the electro-dynamometer. The resistance, r, with a naked wire was placed in a petroleum bath, of which the temperature, kept uniform by agitation, was measured; the resistance was taken again and again and compared with the mercurial standards of Benoît. The relation, $\epsilon = i\,r$, furnished the electromotive force, E, of the cell, T.

The measurements with the absolute electrometer were made alternately by the aid of a commutator suitably arranged; the communication between the extremities of the resistance, R, and either the plate or the exterior of the Leyden jar of the electrometer. In this way the displacement of the plate measured double the electromotive force, n E, existing at the extremities of R. By alternating the experiments at intervals of 30 seconds, any error of observation was eliminated. Each determination involved from ten to twenty alternate experiments.

After studying the experimental arrangements for three years, two definite series of experiments have been effected. The first (May—June, 1890) comprised twenty determinations, and a resistance, R, of one megohm was used, at the extremities of which was a difference of potential equal to 189 volts; it gave as a result :—

$$v = 3{\cdot}0093 \times 10^{10}.$$

The second series of experiments, comprising thirty-three determinations, was made with a resistance R = 2 meghoms, and a difference of potential equal to 378 volts; the result was practically the same, namely,

$$v = 3{\cdot}0091 \times 10^{10}.$$

This number, $3{\cdot}009 \times 10^{10}$, only differs by $\frac{1}{600}$th from the number found by Cornu for the velocity of light, namely,

$$v = 3{\cdot}004 \times 10^{10}.$$

The Thomson electrometer as used, did not permit of a more accurate result than this; still the error due to the electrometric measurement and to other causes, may reasonably be regarded as negligible. In a future memoir I shall give the details necessary for making the proper corrections.

THE AGRICULTURAL HALL EXHIBITION.

THE third International Engineers', Electricians', Builders' and Ironmongers' Exhibition, which was inaugurated at the Royal Agricultural Hall, Islington, on the 23rd ult., and will be closed to-morrow, is very disappointing generally, but from an electrical point of view it is a complete failure. Whether the Islington hall is growing less attractive to exhibitors, or whether electrical firms are becoming tired of participating in exhibitions is not evident, but it is a significant fact that whilst nearly a dozen firms displayed their manufactures at the second show held last year, scarcely one electrical establishment is represented on the present occasion. A collection of primary batteries and incandescent lamps is shown by the Town and County Electric Light Company of 46, Queen Victoria Street, E.C., and Mr. Dan Rylands of 62, King William Street, E.C., exhibits his patent glass lined metal piping for electric light mains and other purposes. Gas engines are well represented by Messrs. Crossley Brothers, Limited, who show two "Otto" engines; "Griffin" gas engines by Messrs. Dick Kerr & Co., Limited; "Stockport" engines by Messrs. J. E. H. Andrew & Co., Limited; "Trent" engines by the Trent Gas Engine Co., Limited; "Leeds" engines by Mr. J. R. Woodhead of Leeds; and "Campbell" engines by the Campbell Gas Engine Co., Limited, of Halifax. Messrs. D. Hulett & Co., Limited, of 55 and 56, High Holborn, W.C., who recently opened an electric lighting department, content themselves with exhibits referring to the gas industry and a few electric bells. Mr. E. S. Hindley occupies his usual stand with a display of his well-known vertical and horizontal steam engines and boilers.

TRIAL OF A 100 HORSE-POWER SIMPLEX GAS ENGINE.

THE trials, of which we give below the results of the longest continuous run, were undertaken by Prof. Witz in order to compare the working cost of a large power gas engine using Dowson gas with that of a steam engine of the same effective horse-power. The comparison was made between a Corliss condensing engine of 75 horse-power output and the gas engine under trial. Given a consumption of 2·35 lbs. of coal per horse-power hour for the steam engine, and taking its ratio of efficiency at 11 to 20 for the gas engine, the professor states that the two sets of plant occupy about the same floor area, and that the total prime cost of the plants would come to nearly similar amounts, £1,280. Interest and depreciation are taken at 15 per cent. per annum for 300 working days of 10 hours each, while the wages of the engineman is charged equally to each apparatus. The figures as estimated are 38s. per day for the steam engine and 31·42 for the Simplex gas engine. Prof. Witz, in his estimate, has based his calculations on the cost of anthracite coal at 25s. 11½d. per ton and coke at 27s. 9d. per ton. Mr. Dowson also gives an estimate of the cost of working a gas engine of 100 indicated horse-power with Dowson gas for 250 days at 10 hours per day, quoting for the consumption of coke at 10s. per ton, coke entirely being used in place of the more expensive anthracite. The result coming out at 24·73s. per day of 10 hours.

Some trials made with Dowson gas in driving engines were carried out at Messrs. Crossley's works, Manchester. In the one case ordinary gas coke was used in the generator, and in another trial anthracite was employed. Coke gave one indicated horse-power for 1·4 lbs.; anthracite producing the same horse-power for 1·2 lbs. With so slight a difference in the consumption of fuel per horse-power, Mr. Dowson considers that he has succeeded in producing his gas practically as well with the cheap fuel as with that of a more expensive nature.

The engine used by Prof. Witz in the trial, the particulars of which are set forth in the table, was a 100 horse-power Simplex gas engine manufactured by Messrs. Matter and Co., of Rouen. It is a single-cylindered engine. The cylinder is 22·64 inches diameter with a stroke of 37·4 inches. There are two flywheels mounted on the shaft. The flywheels are 11·8 feet diameter, and weigh 3·84 tons each. The normal speed of the engine is 100 revolutions per minute. The engine is a four-cycle one, working with an air pressure of 85·4 lbs. per square inch. The distribution of air and gas is effected by one slide and three pot-lid valves, and the ignition is by electricity. The engine works with delayed ignition, so that the explosion does not take place till the crank is 15° past the dead point. This plan lessens the strain on the bearings of the crank shaft, and also enables the ignited gas to expand more rapidly than usual, and the maximum pressure is better maintained. The engine is fitted with a self-starter. The producer was 2 feet 6 inches in internal diameter and 6 feet 3 inches from grate to top.

The air to the generator was induced by a jet of steam, not superheated. The gas on issuing from the producer passed through a scrubber of coke, 9 feet high, through which a current of water was kept flowing, and through a sawdust purifier, to a gasholder of 740 cubic feet, and thence by a 5·1-inch pipe to the motor.

The temperature of the water was taken before entering the jacket, 66·2° F., and after leaving the same, 108·5° F. The exhaust temperature, 824° F., was obtained by the calorimetric method; indicator diagrams were taken by a Richards indicator. The brake used was of the rope type, now so frequently employed. The wheel was kept at a temperature of 79° F., and was cooled by water internally, on the Druitt-Halpin system.

The indicated horse-power was 110·4, the brake horse-power 74·82, therefore the efficiency of the mechanism was 69 per cent. The highest efficiency at the Society of Arts trials was 86 per cent., although for a much smaller engine.

TABLE.

Results of Trial lasting 23 *hours* 30 *minutes.*

FUEL.

Weight of anthracite used	2,030	lbs.
„ of coke used	377·2	„
Consumption of anthracite per brake H.P. per hour	1·155	„
Consumption of coke per brake H.P. per hour	·214	„
Total consumption of fuel per brake H.P. per hour	1·369	„

WATER.

Quantity of water supplied to producer...	34·24	cubic feet.
Quantity of water supplied to scrubber	647	„
„ „ „ jacket...	3,152	„
Consumption of water for producer per brake H.P. hour	·0195	„
Consumption of water for scrubber per brake H.P. hour	·368	„
Consumption of water for jacket per brake H.P. hour	1·793	„
Total consumption of water... ...	2·1805	„

OIL.

Weight of oil used in cylinder ...	14·71	lbs.
„ of grease used in bearings ...	1·76	„
Consumption of cylinder oil per brake H.P. hour	·0084	„
Consumption of grease per brake H.P. hour	·0010	„

GAS.

Total consumption of gas per hour..	6,739	cubic feet.
Height of barometer during trial ...	772	mm.
Temperature of gas on entering engine	21·5	deg. C.
Consumption of gas reduced to 0° C., or 760 mm. per hour	6,345	cubic feet.
Consumption of gas reduced to 0° C., at 760 mm. per brake H.P. per hour	84·87	„

BRAKE.

Total revolutions of engine	142,157	
Average revolutions per minute ...	100·8	
Diameter of brake pulley	5·576 feet	
„ of ropes	·945 m. = ·0788 ft.	
Load on brake...	1,557·4	lbs.
Mean tension of spring at tail end ...	173·9	„
Effective load	1,383·5	„
Brake H.P. (English)...	74·82	H.P.

It is the opinion of Prof. Witz that large-size gas engines will replace steam engines of like power, much as small gas engines, at all events for town work, are at present used in preference to engines that require much personal attention. The whole matter, however, will resolve itself into one of convenience and cost, and the motor that will be most used will be that one which will give the minimum of trouble to the user, and whose cost shall not be prohibitive.

AN EFFICIENT PLATING DYNAMO.*

THE armature for plating has but a single layer of wire, with two convolutions to each layer. To facilitate winding, two parallel wires, No. 10 B. and S. gauge, are used in each coil instead of using a single larger wire. Fig. 1 shows the armature complete, and Fig. 2 shows the armature core in section with the dimensions marked on.

It consists of an iron spool filled with No. 18 or No. 20 very soft iron wire, either rusted or varnished to prevent Foucault currents.

The heads of the spool are provided with 20 radial slots in which are inserted the small wedges, *a*, separating the coils of the armature. The wires forming the coils are each about 20 inches long. The winding is according to the Froelich method. Coil 1 (consisting of two parallel wires as described) is placed entirely upon one side of a diametrical line of the armature, and begins and ends on the opposite side of the armature. Coil 2 is placed on the opposite side of the same diametrical line, and begins and ends on the opposite side of the armature. Coil 3 begins on the same side of the armature as coil 1, adjoining coil 2 on that side, but leaving a space between it and coil 1 on the opposite side of the armature for coil 4, which is to be started and finished on the same side of the armature as coil 2. Coil 4 will adjoin coil 3 on the side of the armature opposite that on which the coil is started and finished. The armature is proceeded with in this manner until all the spaces are filled up and the coils are all in place with their ends projecting as shown.

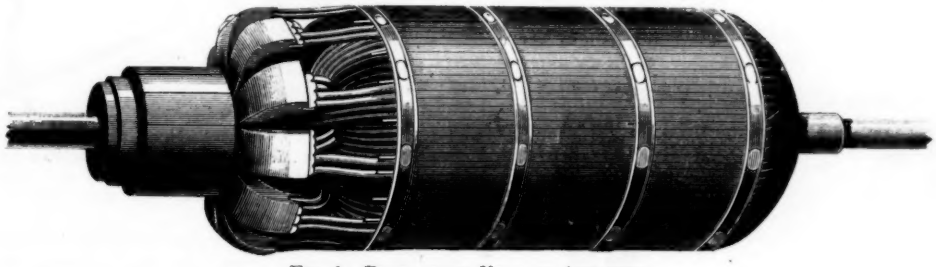


FIG. 1.—PERSPECTIVE VIEW OF ARMATURE.

There are ten coils, and the same number of bars in the commutator cylinder. Each commutator bar receives the end of one coil and the beginning of the next, so that the coil is closed.

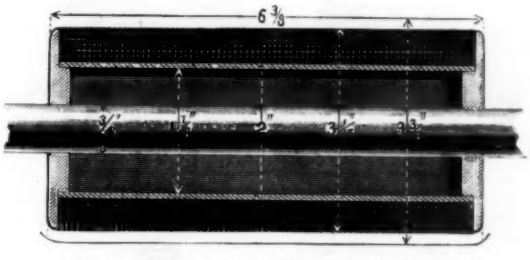


FIG. 2.—LONGITUDINAL SECTION OF ARMATURE.

If desired, the coil may be wound according to the Siemens (or Hefner-Alteneck) method, provided a commutator cylinder has an odd number of bars and the armature an odd number of coils. The Siemens method thus modified is, in fact, the Edison winding.

* By Geo. M. Hopkins, in the *Scientific American Supplement.*

In the present case each bar has formed integrally with it a radial arm which is bent toward the armature core, and slots, R, are made in the end to receive the terminals of the coils, which are soldered in the slots. The arrangement of the terminals of the coils is the same as in the Siemens armature

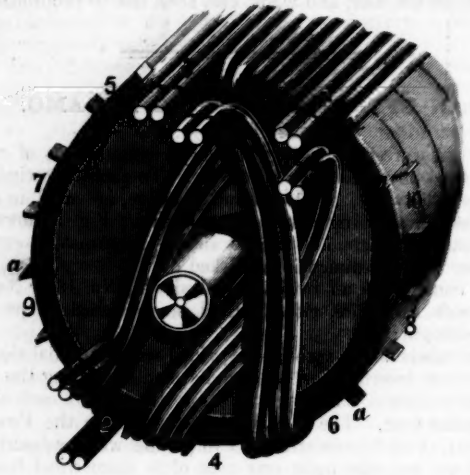


FIG. 3.—COMMUTATOR END OF ARMATURE.

—*i.e.*, each commutator bar receives the end of one coil and the beginning of the next.

The commutator cylinder is built up on a flanged sleeve,

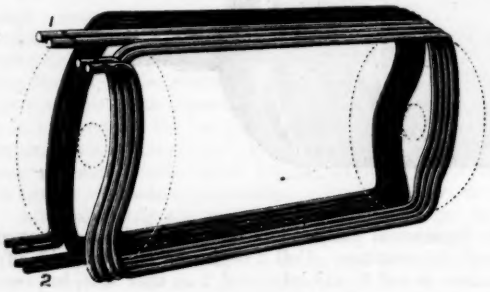


FIG. 4.—TWO ARMATURE COILS SEPARATE FROM CORE.

M, fitted to the armature shaft. The flange of the sleeve is grooved in the side to receive the lugs projecting from the commutator bars, P. A tube, O, of insulating material, such

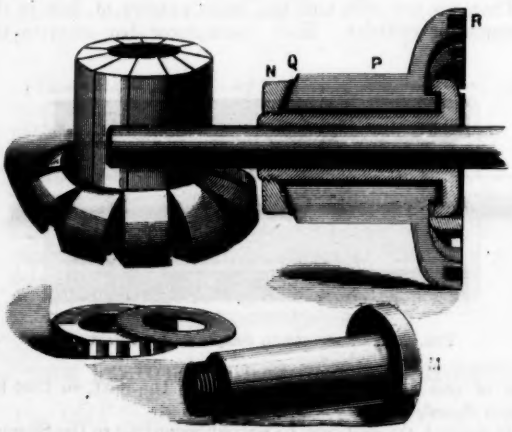


FIG. 5.—DETAILS OF COMMUTATOR.

as hard rubber or vulcanised fibre, is slipped over the sleeve, M, and the groove in the flange of the sleeve is lined with insulating material. A countersunk nut, N, is screwed on the end of the sleeve, M. Between the nut and the bevelled ends of the commutator bars is placed an insulating washer, Q. The bars, P, are separated from each other by mica.

The commutator brushes used on the eight-light dynamo* will answer for this armature, but wider ones would be preferable.

The field-magnet is used in connection with the armature here shown and described, but a switch is required by means of which the current may be sent through all the coils in series, or all in parallel, or with any intermediate arrangement, so that the current can be controlled at will.

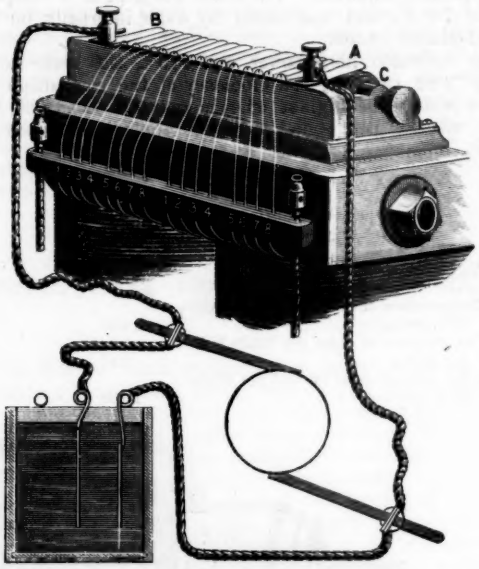


FIG. 6.—TOP OF F.M. WITH SWITCH AND DIAGRAM OF CONNECTION FOR PLATING.

The switch is made in cylindrical form with metallic plates and connections as shown in fig. 7, in which the surface of the cylinder is spread out flat to permit of easy explanation.

The cylinder forming the body of the switch is of wood. It is provided with journals which revolve in bearings in a wooden frame attached to the top of the field-magnet. On the ends of the wooden cylinder are mounted copper rings, C, D, which are pressed by springs, A, B, connected with the commutator brushes, as shown in fig. 6. Between the rings, C, D, are arranged four series of plates, which may be brought

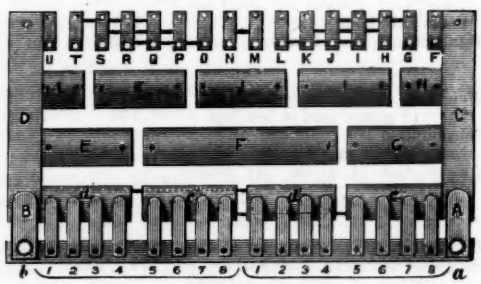


FIG. 7.—DIAGRAM OF SWITCH.

into contact with the series, *a*, *b*, of springs secured to the wooden switch frame and connected with the terminals of the separate coils of the field-magnet—the terminals 1, 2, 3, 4, 5, 6, 7, 8, of one-half of the field-magnet being connected with the series *a*, those of the other half being connected in the same way with the series *b*.

With the switch in the position shown in fig. 7, the current arrives at the spring, A, from the armature, passes to the ring, C, thence to the plate, *c*, and through the connecting-wire to the plate, *c'*, thus causing the current to pass down

* See ELECTRICAL REVIEW for May 6th and 13th, 1887.

the field-magnet wires, 5, 6, 7, 8 of each series. It returns to the switch through wires 1, 2, 3, 4 of each series to the plates, *d*, *d'*, which are connected electrically, as shown.

From the plates, *d*, *d'*, the current flows to the ring, D, and spring, B, thence back to the armature. By this arrangement all the coils of the field-magnet are thrown in parallel. By turning the switch so as to bring the springs in contact with the plates, E, F, G, the arrangement is such that the current flows through four coils in parallel and two in series. By bringing the plates, H, I, J, K, L, into contact with the springs, the current passes through two coils in parallel and four in series, and when the switch is turned so as to bring the plates, F, G, H, &c., in contact, the current passes through all the coils in series, *i.e.*, the current passes through the winding of the field-magnet as it would through an ordinary electro-magnet, *i.e.*, it passes from plate F, through spring 8, and one coil of the magnet to plate J, thence by the cross connection to plate G, through spring 7, and another coil of the magnet to plate K, and so on.

By means of this switch the current may be adapted to electrotyping, or brass, nickel, silver, or gold plating. At 2,500 revolutions per minute, with field-magnet in shunt, with current split, running down both arms of the magnet in parallel, as first described, the machine yields a current of 55 amperes with an E.M.F. of 5 volts. The current may be varied from 50 to 85 amperes with an E.M.F. of from 2½ to 5 volts and upward.

REVIEWS.

A Dictionary of Metric and other Useful Measures. By LATIMER CLARK, M.I.C.E., M.I.E.E., F.R.S.; F.R.A.S. E. and F. N. Spon, 125, Strand, London. New York: 12, Courtlandt Street, 1891.

This work, although short, containing a little over 100 pages, is full of a vast amount of useful information, especially valuable to those who so frequently require to make calculations where the metric system is used. The short title of "Metric Measures" by which the book is tersely called, scarcely conveys the true purpose of the work, and would under that name fail to attract those to whom it would be especially applicable.

The author, in his preface, remarks: "These pages are primarily intended as an *aide-mémoire* for the use of those who have occasion to employ metric and other physical measures." We venture to think that those who have once employed this work to assist them in their usual calculations will find it of such frequent use and value that it will become a substitute, rather than an aid, to the memory, for throughout its pages will be found not only all the ready calculations for the conversion of one measure to another, but also the reciprocals.

Although the author states that "no attempt has been made in the present volume to include the numberless and very variable measures in local use in less civilised portions of the globe," yet a very large number of foreign and almost unknown measures are given. We will quote two only: "Aune, old French ell;" "Blue (Wales), one-twelfth of a gallon." But under the heading of "Stone" we do not see that a "stone of wire" = 12 lbs. as known in Yorkshire, nor is the Winchester measure of sulphuric acid given.

The arrangement of the work is in alphabetical order, and it affords a very ready method of obtaining speedily the desired information; of this the author remarks, "but the chief gain will be found to arise from the uniformity of arrangement, the ease of reference, and the prescriptive directions, which soon become familiar, and which enable one to use the figures as it were mechanically, even while engaged in conversation or argument, without interference with the train of thought on which the mind is engaged."

In this dictionary the arrangement is, in order to convert one measure into a second, the figures are given first of the number to multiply by, and secondly the reciprocal to divide by, in the third column the logarithm (to five figures) of the multiplier. Thus to convert "kilometres" into "miles" multiply by ·62138, divide by 1·6093, log. $\bar{1}$·79336. A reference to "miles" into "kilometres" will find the second figure as the multiplier, but in this instance the reciprocal, for some reason, is not given. This we find to be the case with many other instances, and we also notice that in various places the logarithm is given, but the multiplier appears to have been omitted, whether purposely or not we cannot say.

In addition to the large amount of measures given will be found some useful information under other heads, as, for instance, under "Copper," we find its resistance, weight, &c.; but whilst the effect of annealing is mentioned, no notice has been taken of the now very important process of "tinning," the peculiarity of this process being that the added weight of the "tin" cannot be measured, and the increased diameter of the wire cannot be gauged. Under the head of "Water" is also to be found a great deal of useful information. The book concludes with some useful tables, including some well-arranged logarithms and anti-logarithms.

We can only conclude our remarks with the expression of our opinion that Mr. Latimer Clark has placed before us an exceedingly valuable and useful book, which, in a very small compass, contains more necessary and ready numerical references than will be found elsewhere. The long and successful practical experiences of the author in varied branches of his profession has enabled him to safely place before others what his own practice has shown to be necessary and useful.

Handbook for Mechanical Engineers. By HENRY ADAMS. Second Edition. Revised and enlarged. E. and F. N. Spon, 125, Strand, London.

This excellent collection of engineering notes is of considerable value. The book is in many respects of the Molesworth type, though it contains more descriptive matter, and the usual lengthy tables of circles, logarithms, &c., are conspicuous by their absence. The authorities for the various formulæ are given in most cases. At the end of the book the syllabus of the City and Guilds of London Technical Institute, with reference to iron and steel manufacture, electrical engineering, metal plate work, tools, and mechanical engineering, is given in full, together with the similar syllabus of the Government Department of Science and Art, and of the City of London College Engineering Department. We may add that a feature in the book is the excellent style in which the matter is printed, a characteristic of all Messrs. Spon's publications.

A Treatise on the Law and Practice relating to Letters Patent for Inventions. By ROBERT FROST, B.Sc. London: Stevens and Haynes, Bell Yard, Temple Bar.

This bulky volume is an attempt to bring within a reasonable compass the law, as it at present exists, in reference to letters patent in England. The whole subject is an intricate one, and one with which it is difficult to deal satisfactorily. The chief part of the matter consists of numerous law cases, in which the points with reference to various kinds of infringements are mentioned. Great care appears to have been taken in the compilation, and a very large amount of ground is covered.

Journal of the Institution of Electrical Engineers. No. 92. London: E. and F. N. Spon, 125, Strand.

The contents of this number are as follows:—Discussion on Major-General Webber's paper on "Electric Lighting from Central Stations, with Special Reference to the Chelsea System;" "Transformer Distribution," by J. Swinburne; discussions on same; Abstracts, &c.

Formulaire Pratique de L'Electricien. Par E. HOSPITALIER. Neuvième Année. Paris: G. Masson, Editeur, Libraire de l'Académie de Médecine, 12, Boulevard Saint-Germain.

As each succeeding edition of this excellent work appears there is always some improvement to note. In the present edition the chief additions as regards the theoretical portions of the book relate to periodic currents, the increase in resistance of conductors traversed by them, their measurement, &c. The practical portions added relate to gas burning, specific resistances, magnetic constants, &c. In the fourth part of the book, in which the distribution of electric power, dynamos, &c., are dealt with, much recent matter has been worked in, so that the whole is brought, as far as possible, well up to date.

Journal of the Institution of Electrical Engineers. No. 91. London: E. & F. N. Spon, 125, Strand.

The contents of this number are as follows:—Inaugural Address of the President, Prof. William Crookes; "Electricity in Transitu: from Plenum to Vacuum," "Electric Lighting from Central Stations, with Special Reference to the Chelsea System," by Major-General C. E. Webber, C.B. Original Communication:—"Early History of the Telegraph in India," by P. V. Luke. Abstracts, &c.

L'Année Electrique ou Exposé Annuel des Travaux Scientifiques des Inventions, &c. Par PH. DELAHAYE. Septième Année. Paris: Baudry et Cie, Editeurs, 15, Rue des Saints-Pères.

This hardy annual continues to keep up its high standard of completeness; considering the entire absence of illustrations, the subject matter gives a remarkably clear notion of the multifarious subjects dealt with. Both as a work for immediate and for future reference it possesses, and will possess, great value.

Intensity Coils: How Made and How Used; also Electric Light, Telephone, and Phonograph. 16th Edition. By DYER. London: Perken, Son and Rayment, 99, Hatton Garden.

We can well remember the first edition of this book, and though we had lost sight of the work for some years, we are not surprised to find that it has gone through so many editions as 16. The original matter was so good that but little could be done to improve it; the additional pages, however, are hardly up to the useful character of the older portion, being far too sketchy to be of material value.

The History of Electricity in America.

We have received copies of the March and April numbers of the *New England Magazine*, an illustrated American monthly, containing very interesting articles by G. H. Stockbridge on the "History of Electricity in America." The article in the March number deals with the early history, commencing with Benjamin Franklin, of whom a portrait is given. An illustration of the original Franklin electrical machine, now in the Franklin Institute, is interesting. Prof. J. Henry is next alluded to, and the valuable work done by him receives ample justice. Prof. Morse, and the share which he took in the invention of the practical electric telegraph, are next spoken of, due mention being made of the important part which Vail played in the matter. Page, and the important work which he did in connection with electromotor and other apparatus, are duly chronicled, and in all cases care is taken to apportion a due share of credit to those whose names are comparatively unknown, but who have an undoubted right to be mentioned in connection with useful work done.

In the April number the names of Cyrus Field, Edison, Elihu Thomson, E. Weston, Graham Bell, Brush, and others, appear, and the work done by them is detailed in an interesting manner. Altogether the articles are well worth reading.

LONDON COUNTY COUNCIL.

AT the usual weekly meeting the following report of the Highways Committee was presented:—

ELECTRIC LIGHTING—PROVISIONAL ORDERS, 1891.

On the 14th instant we reported that we had suggested to the Board of Trade that certain amendments should be made in several electric lighting provisional orders of this session; and we have now to report that a letter has been received from the board, stating that the amendments suggested by us on behalf of the council have been made in the Westminster order.

We have considered the Southwark electric lighting provisional order, which has been forwarded by the Board of Trade; and have suggested to the board similar amendments to those with reference to the Wandsworth and other orders reported last week, with the additional suggestion that clause 59a, which relates to the transfer of the undertaking to a company, shall be so amended as to require notice of such intended transfer to be given in the manner required by the Standing Orders of Parliament, and that no transfer shall take place unless authorised by Act of Parliament. We recommend that the course taken by us with reference to the Southwark electric lighting provisional order be approved.

SUBWAYS.

We have considered an application of the National Telephone Company for permission to repair and partly replace existing cables connecting the Grand Hotel with the Northumberland Avenue subway. We see no objection to this; and we recommend that the National Telephone Company be permitted to carry out the work referred to in the application, under the supervision of the chief engineer of the council, and upon condition that any damage that may be done to the subway in the execution of the work shall be made good to his satisfaction and at the sole cost of the company.

NOTICES UNDER ELECTRIC LIGHTING ORDERS AND ACTS.

We have had before us a letter from the London Electric Supply Corporation, stating, with reference to the requirement attached to the council's sanction of the works referred to in the company's later notices that each of the street boxes shall be provided with a double cover, that concentric cables are to be used, and that their construction and use are such that shocks are impossible, and the company asks that the requirement may be withdrawn. The chief engineer has reported, after inspection of the concentric cables, that where they are used the provision of the second covers may be dispensed with, but that certain conditions with reference to the protection of them from injury should be laid down. He further states, as a result of his inspection, that there appear to be in some of the company's street boxes some disused cables, and that these may be a source of danger unless removed. We recommend that the London Electric Supply Corporation be informed that in those cases where concentric cables are used, the council's requirement as to the provision of the second cover to each of the street boxes will not be insisted upon; but that the council requires that all electric lines, other than those in actual use, shall be removed from the street boxes; that all pipes or openings from or into the boxes shall be of such shape as to remove all risk of injury to the covering of the cables; that cables crossing the boxes shall be supported from below in the boxes; that all service lines or small cables shall be protected, where leaving the boxes, by an extra lead covering, or by wooden stoppers, and shall also have a copper wire of sufficient size carried from the service to the main cable, in good connection with the lead or iron outer casing; that nothing shall be kept in any box but the electric lines in actual use, and that the ends of all mains terminating elsewhere than in a box shall be securely protected by iron caps in addition to any other covering.

We have considered a notice, dated April 13th, 1891, from the London Electric Supply Corporation, of intention to lay distributing mains in North Row, Green Street, Wood's Mews, and Norfolk Street, in the parish of St. George, Hanover Square (1 plan, D.M., 12/91). These mains will consist of cast-iron pipes with lead-covered concentric cables drawn into them; and the conditions above stated will apply. We recommend that the sanction of the council be given to the works referred to in the notice of the London Electric Supply Corporation, dated 13th April, 1891, on condition that the company do give two days' notice to the council's chief engineer before commencing the works; that the mains be laid under the footways and be kept 9 inches below the under side of the paving whereever it is found practicable to do so; that where the mains cross the carriageways they be kept at the same depth below the concrete or the road material as the case may be; that all pipes or openings from or into the boxes shall be of such shape as to remove all risk of injury to the covering of the cables; that all cables crossing the boxes shall be supported from below in the boxes; that all service lines or small cables shall be protected, where leaving the boxes, by an extra lead covering or by wooden stoppers, and shall also have a copper wire of sufficient size carried from the service to the main cable in good connection with the lead or iron outer casing; and that the ends of all mains terminating elsewhere than in a box shall be securely protected by iron caps in addition to any other covering.

We have also to report the receipt of the undermentioned notice, given by the London Electric Supply Corporation, in accordance with the resolution of the council to accept four days' (instead of one months') notice in respect of the laying of service lines from mains already laid:—"9th April, 1891—To 27, New Bond Street, and 1, 3, 4, 17, and 19, Coventry Street."

SUBWAYS.

We have received a report from the engineer with reference to a fire which occurred in the Northumberland Avenue subway on April 1st, by which some slight damage was done to wires belonging to the Post Office Telegraphs Department. The origin of the fire cannot be precisely ascertained; but it is supposed that a lighted pipe may have been left in a coat belonging to one of the flushers who used the subway for the purpose of changing their clothes before entering the sewers, or that a sewer lamp may have been left alight in the subway and by some means got upset. The use of the subway by the flushers has now been discontinued. In the course of our enquiries into this matter we have ascertained that there is at present no effective control exercised over the use of the council's subways; and although the council, on our recommendation, caused locks to be placed on the entrances to the subways, these locks have not yet been used, owing to the objections offered by the companies and others using the subways, and it is possible for persons to enter the subways without the knowledge of the council's officials. The council, on the 19th of November, 1889, made bye-laws relative to the use of certain of the subways; and these were subsequently confirmed by the Board of Trade and by the Secretary of State for the Home Department, and came into force in March of this year. As, however, these bye-laws

cannot be made to apply to all the subways of the council (from the incomplete powers of the council in this respect), we have been preparing, and hope soon to submit to the council, regulations applicable to all the subways. In the meantime, however, we think that as a matter of precaution, and for the protection not only of the subways themselves, but of the pipes and wires therein belonging to the various companies and others, the entrances to the subways should be kept locked, proper facilities being given for authorised persons to enter them when requisite. This step however should, in our opinion, not be taken without due notice being given to the companies and others concerned; and we therefore recommend "That notice be given to the Postmaster-General and to each of the gas, water, electric lighting and other companies having pipes, wires, or other apparatus in the council's subways, that on and after the 1st of June next, the entrances to the subways will be locked, and be kept locked; that companies and others desiring to enter a subway for any purposes, must, except in cases of urgency, which will admit of no delay, give to the council's chief engineer at least 24 hours' notice in writing of the time at which they wish so to enter; and, further, that all persons contravening the council's bye-laws and regulations relative to the subways, will be held responsible for the consequences.

ELECTRIC LIGHTING—PROVISIONAL ORDERS, 1891.

We reported, on the 14th of April, that we had submitted to the Board of Trade on behalf of the council amendments which in our opinion should be made in several electric lighting orders specified in the report; and we have now, for the information of the council, to state that letters have been received from the board to the effect that in the Clerkenwell, Islington, Hackney, Woolwich district, Camberwell, St. Luke's Middlesex, Wandsworth, and Southwark orders, most of the suggested amendments have been made. Those amendments which have not been adopted by the board do not, in our opinion, relate to matters of very great importance, and we therefore do not advise the council to further press them.

NOTICES UNDER ELECTRIC LIGHTING ORDERS AND ACTS.

We have considered a notice, dated 15th April, 1891, from the London Electric Supply Corporation of its intention to lay trunk mains in Cockspur Street, Spring Gardens, Buckingham Palace Road, Lower Grosvenor Place, and Ebury Street. The plans show that the mains will also be laid along The Mall, St. James's Park, which place, however, is not specified in the notice to the council; and as this is Crown property, the council has no jurisdiction there. There appears to be no reason for objection to the laying of the proposed mains; but drawings of the junction box, proposed to be placed in Cockspur Street, should be submitted for approval before the box is constructed. We recommend that the sanction of the council be given to the laying of the trunk mains referred to in the notice (Registered No. 195) of the London Electric Supply Corporation, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works; that the mains, where laid under the footways, shall be kept two feet below the underside of the paving, and where they cross the carriageways at the same depth below the concrete, or if this be found to be impracticable, that the mains be protected from mechanical injury to the satisfaction of the council's chief engineer, and that drawings of the junction box proposed to be placed in Cockspur Street shall be submitted for the approval of the Highways Committee before the box is constructed.

We have also to report the receipt of the undermentioned notices from the same company, given in accordance with the resolution of the council to accept four days' (instead of one month's) notice in respect of the laying of service lines already laid:—

21st April, 1891.—To 31, Savile Row, 33, Aldford Street, 35, Clarges Street, 8, Seamore Place, 67, New Bond Street and 17 and 31, George Street.
22nd „ To 12, Hanover Street, 18, Maddox Street, 2, 3, 8, 9 and 10, Great Pulteney Street, and the "Blue Posts" public house, Rupert Street.
22nd „ To the "Royal Aquarium," Westminster.

We have likewise considered two notices from the Notting Hill Electric Lighting Company, dated 17th and 20th April, 1891, respectively, of its intention to lay mains from No. 1, Airlie Gardens, crossing Campden Hill Road, and along Percy Villas to Hypatia Villa (1 plan, 38A), and across High Street, Notting Hill Gate, south to No. 135. The proposed works are unobjectionable; and we recommend that the sanction of the council be given to the works referred to in the notices (Registered Nos. 196 and 197), dated 17th and 20th April, 1891, respectively, of the Notting Hill Electric Lighting Company, upon condition that the company do give two days' notice to the council's chief engineer before commencing the work; that the covering stones of the culvert shall be not less than 2 inches thick; and that where the culvert crosses the carriageway, there shall be at least 9 inches thickness of Portland cement concrete above the cover stones of the culvert in addition to the road material.

REPORT OF THE OFFICES COMMITTEE.

ELECTRIC LIGHTING.

The council on the 13th of January last gave us authority to obtain tenders for the necessary fittings, &c., for providing the electric light for the large room under the council chamber, and for one of the rooms on the ground floor occupied by some of the clerks in the clerks' department. After we had obtained this authority it appeared to us that it would be advantageous to extend at the same time the electric light to the chief engineer's room, the "fees and fines" room in the comptroller's department, and to another room pertaining to the clerks' department. We accordingly gave instructions for the fittings for these rooms to be included in the specification. We invited tenders from seven firms, and the following were received, viz., Messrs. Thompson and Ritchie, £172 6s.; Messrs. Crompton and Co., £210 10s.; Mr. H. South, £240; Messrs. M. J. Scott and Co., £245; and Messrs. Strode and Co., £248. We recommend that, subject to an estimate being submitted to the council by the finance committee as required by the statute, the tender of Messrs. Thompson and Ritchie be accepted, and that the solicitor be instructed to prepare a contract with them accordingly.

LEGAL.

The Kensington and Knightsbridge Electric Lighting Company, Limited, v. the Lane-Fox Electrical Company, Limited.—This was a motion by the plaintiff company before Mr. Justice Stirling, asking for an injunction to restrain the defendant company from threatening the plaintiffs, their customers, or any other person or persons with legal proceedings or liability in respect of any alleged infringement of certain letters patent claimed by the defendants to have been assigned to them. The letters patent related to an invention of which Mr. St. George Lane-Fox, an electrical engineer, was the author. He was the registered owner of the patent, but he had by an agreement, dated July 31st, 1890, agreed to assign it to the defendant company, of which he was the managing director and a large shareholder. On November 15th, 1890, he commenced an action against the plaintiff company to restrain them from infringing his patent, but the plaintiff company had not yet put in their defence. On February 21st, 1891, the defendant company sent the following letter to Messrs. John Barker and Company, of Kensington:—

"We understand that your house is being supplied with electric light by the Kensington and Knightsbridge Electric Supply Company, which company, as you are doubtless aware, is now being sued for damages for infringement of our patented system of electric distribution. We have been advised that you, as one of the users of the said system, are liable for the infringement. We beg, therefore, to caution you of the fact, and to offer you an indemnity upon the terms contained in the enclosed circular. These terms, however, are to be considered as withdrawn if not accepted by the 28th inst."

The circular referred to in this letter was to the effect that the Lane-Fox Electrical Company, Limited, by whom all Mr. Lane-Fox's patents for this system of electric light distribution were stated to be held, were prepared to grant licenses for the use of the system on certain terms therein set out. A similar communication had been sent by the defendant company to numerous other customers of the plaintiff company, and it was against this course of action that the present motion was directed. It was said, on behalf of the defendant company, that it had been decided that where an action had been commenced before the threats were made, an injunction to restrain the threats would not be granted; and here such an action had been brought. It was necessary to bring the action in Mr. Lane-Fox's name, the patent being vested in him, but the defendants were the real owners in equity. The question turned upon the construction of section 32 of the Patents, &c., Act, 1883, which provides that:—

"Where any person, claiming to be the patentee of an invention, by circulars, advertisement, or otherwise, threatens any other person with any legal proceedings or liability in respect of any alleged manufacture, use, sale, or purchase of the invention, any person or persons aggrieved thereby may bring an action against him, and may obtain an injunction against the continuance of such threats, and may recover such damage (if any) as may have been sustained thereby, if the alleged manufacture, use, sale, or purchase to which the threats related was not in fact an infringement of any legal rights of the person making such threats. Provided that this section shall not apply if the person making such threats with due diligence commences and prosecutes an action for infringement of his patent."

Mr. Graham Hastings, Q.C., and Mr. Wallace were for the plaintiff company; and Mr. J. C. Graham for the defendants.

Mr. JUSTICE STIRLING said that no doubt the letter complained of contained a threat. The defendant company claimed by the circular to have acquired the rights of the patentee of the invention, and were therefore within the definition of the Act. By the Act any person aggrieved might bring an action against any one uttering threats. The plaintiff company were undoubtedly persons aggrieved, and might bring an action against any person whose "legal rights" were alleged to be infringed. But here the defendant company had no legal rights, for Mr. Lane-Fox had only agreed to assign his rights to them. Therefore the defendant company, the persons making the threats, were simply entitled in equity to an assignment of the patent upon certain terms not disclosed. That the defendant company were not entitled to sue was clearly shown by the fact that Mr. Lane-Fox had brought an action in his own name. The constitution of the company was somewhat remarkable. The capital consisted of 100 £1 shares, which were deemed to have been fully paid up, and Mr. Lane-Fox might have good reason for not wishing to clothe them with the legal title so as to enable them to sue in respect of an infringement. There was only an equity here, to enforce which the company would have to bring an action against Mr. Lane-Fox. Then did the proviso apply? The action was not brought by the persons making the threats, but by the legal owner of the patent, Mr. Lane-Fox, and damages for the threats could only be recovered from this company with a nominal capital of £100. Consequently, an order must be made for an injunction to restrain the continuance of such threats.

Latimer Clark, Muirhead and Company, Limited, v. the Westminster Electric Supply Association, Limited.—This case came before Mr. Justice Hawkins and a special jury and was concluded on Tuesday. The case was that the defendants, being desirous to supply parts of Westminster with electric light power, engaged the plaintiffs to assist in obtaining the necessary provisional order and the statute to carry it out. Upon this work being successfully carried through, the defendants contracted to give to the defendants work in connection with the supply of the district to the extent of £100,000. The sole condition upon which this employment was to depend was that the defendants should go to allotment in reference to some new capital to be raised; and they did in fact go to allotment. The contract was put into writing, and was deposited with a firm of solicitors, and plaintiffs now claimed damages upon the ground that it had not been carried out.

The defence pleaded was that the alleged contract never was a completed act, but was a mere escrow, and was not to come into operation until the plaintiffs had taken 3,333 £5 shares in the proposed capital, but these shares they never had subscribed for.

A good deal of documentary evidence was put in and witnesses were examined.

Mr. JUSTICE HAWKINS intimated that in his opinion very difficult questions were likely to arise in the case, and it could hardly end without further litigation. He therefore suggested that, if possible, some arrangement should be come to between the parties.

After considerable discussion this suggestion was acted upon, and it was arranged that £4,000 should be paid to the plaintiffs to include everything; that bygones should be bygones; and that any tenders of the plaintiffs for future work for the company should be fairly considered by the directors with any others that might be sent in.

PARLIAMENTARY NOTES.

ELECTRIC LIGHTING.

IN the House of Commons, last Friday, in reply to Mr. S. Balfour, Sir M. Hicks-Beach said, the Board of Trade have no power to revoke a provisional order unless the undertakers fail to comply with the requirements of the order within the prescribed time. In the only case in which the Board of Trade propose to grant a third order in a district this Session, they have reason to believe that one of the existing companies will not be in a position to comply with the requirements of their order within the time prescribed thereby. If this should be so, the Board of Trade will, when the proper time arrives, consider any application for the revocation of the order that may be made to them by the County Council or the local authority.

NOTES.

Extension of Lighting in Berlin.—The Berlin Electricity Works is about to extend its service by laying down a number of new cables in various thoroughfares.

The Hamburg Fire.—The fire which occurred in Hamburg last week partially destroyed several of the dynamos used for lighting warehouses, and caused a cessation in the supply of light.

The Estimation of Rhodium by the Electrolytic Method.—A paper, chiefly interesting in its details to analytical chemists, was presented to the Academy of Science at Paris, on April 18th, by A. Joly and E. Leidié, in which they describe the application of the electrolytic method to the estimation of rhodium. Rhodium can be determined in solutions with great accuracy by the electrolytic method, provided that there are no metals present other than those of the alkalies. Examples are given in the original paper of this application in the case of solutions in hydrochloric, sulphuric, and nitric acids. The metal separates well, and forms a very coherent deposit at the negative pole. One curious result was observed. When a compound of rhodium with oxalic acid was electrolysed, no metallic deposit formed at the negative pole, but at the positive pole a peroxide of rhodium was thrown down. Rhodium is best estimated electrolytically in the form of the sulphate or chloride; an excess of acid retards the deposition of the metal. This investigation is stated to be the first step in a series of researches which have been undertaken with the object of providing a good electrolytic process for separating the metals of the platinum group from each other, or from the common metals, such as copper, lead, iron, bismuth, and zinc which occur, or are introduced, often as impurities in the course of the commercial preparation of the platinum metals.

The Vienna Postal Congress.—During the month of June a Postal Congress is to be held in Vienna, at which the different countries forming the Postal Union will be represented. This Congress will complete the work of those held at Berne in 1874, Paris, 1881, and Lisbon four years later.

Telephony between Brussels and Berlin.—When the London-Paris telephone line was inaugurated, the *Independance Belge*, of Brussels, commenced a news service between London and Brussels *viâ* Paris. The same paper has now arranged a combined telegraphic and telephonic service between Brussels and Berlin.

An Anglo-German Cable.—For some time now negotiations have been proceeding between England and Germany for the laying down of a direct cable between the English and German coasts. Up to the present the telegraphic relations between the two countries have been assured by cables laid down on the French, Belgian and Dutch coasts. The new cable now under consideration will therefore form a fourth telegraphic line. The negotiations between the two Governments have been most satisfactory, and the immediate signature of the agreement is now expected.

Electrically Exploded Fog Signals.—Says the *Railway News*:—One of the latest forms of fog signalling is that invented by Mr. Norman Staniland, of 14, Southgate Street, Bath. The apparatus for carrying and exploding the cartridges is fixed on the locomotive, and is adapted to be worked by the compressed air or vacuum of the brake reservoirs. An outer fixed cylinder has a smaller cylinder sliding into it, this latter having a tube fixed diametrically across it. The compressed air can only escape to the atmosphere through this cylinder and tube. The compressed air first forces a cartridge from the magazine into the tube, thus closing egress of the compressed air. The inner cylinder is then forced along till the cartridge in tube is in a safe position for firing. In moving up, the two needles have been forced into the cartridge. An electrical contact wheel is suspended from the locomotive. When this comes on a rail fixed for the purpose an electric circuit is closed, and a spark sent between the two needles. The cartridge is exploded, allowing the compressed air to escape, and the tube is pulled back by a spring to repeat the operation. The moving parts are simple, and the working is free from shocks. The electrical apparatus consists of a battery and a small sparking coil carried on the engine.

Grafton Electrical and Medical College.—This institution has been recently started at 35, Fitzroy Square, W., by Mr. H. Newman Lawrence, M.I.E.E., and his able colleague, Dr. Arthur Harries, for training nurses and others in medical electricity and massage. It forms a fresh evidence of the energy of these gentlemen in their efforts to place in a satisfactory and scientific position medical electricity and its cognate subjects. We have been favoured with copies of the syllabus of lectures for the term, and also with the questions set at the examinations which concluded the first term's work. From these it is evident that a very useful training is to be obtained at the college. The value of the certificate given to the successful students is clearly evidenced by the fact that independent examiners, in the persons of W. E. Sumpner, D.Sc. (Lond.), and J. Russell Harris, M.D., M.R.C.S., have been called in to examine, the former on electricity, and the latter on anatomy and physiology. We note with satisfaction that some free studentships are offered to trained nurses, and trust that Grafton College may receive the support it justly merits. We wish to point out, however, that Dr. Sumpner has evidently set some of his examination questions thoughtlesssly. Take No. 5 for instance: in this the battery "whose electromotive force is $1\frac{1}{2}$ volts," with 2 ohms internal resistance, would not, when its terminals were joined by a piece of wire of 4 ohms resistance, give the result which a student would calculate from the given data, because, with so low an external resistance, the E.M.F. would not be the same on closed circuit as when open, and Dr. Sumpner does not refer to this peculiarity; *i.e.* $\frac{1{\cdot}5}{2+4} = {\cdot}25$ ampère would be erroneous.

The Frankfort Exhibition.—The managing committee of this exhibition states that the inauguration will take place at midday on the 16th inst.

Society of Arts.—Last Wednesday evening a paper on "The Uses of Petroleum in Prime Motors" was read by Prof. William Robinson, M.E.

Personal.—The Secretary of State has appointed Mr. A. A. Campbell Swinton to be permanent consulting electrical engineer to the Metropolitan police.

The Elmore Process.—We have received at the last moment a letter from "An Elmore Shareholder," touching upon Mr. Watt's letter. Being too late for insertion in this issue we must reserve it for our next.

Drake and Gorham.—Messrs. Drake and Gorham have issued a list of electrical apparatus, dated this month, in which reduced prices are quoted for their adjustable ring-contact switches.

The Henry Dry Cell.—The General Electric Company have lately introduced into the market the Henry dry cell, which they find to be thoroughly reliable and in all respects to meet the demand for a clean, compact and convenient battery for portable, outdoor and transport purposes.

Institution of Electrical Engineers Students.—A general meeting of the students of the institution was held on Friday, April 24th, when a paper was read by Mr. G. U. Yule on "Alternate Current Motors." The next meeting will be held on Friday, May 8th.

Central Station in Christiania.—A central station is projected for this town for 4,000 lamps, the plant to be on the three-wire system. The station is to be contracted for by tender, and the competition will shortly be opened.

Liquidations.—Notices have appeared in the *Gazette* that the Electro-Metallurgical Company, Limited, and the Electrical Engineering Corporation, Limited, have resolved to be wound up voluntarily. Mr. John James Bedney Arter, of 26, Waterloo Street, Birmingham, is appointed liquidator in the first case, and Mr. Francis William Pixley, of 24, Moorgate Street, London, in the other.

Cuttriss, Wallis and Company, Limited.—Messrs. Cuttriss & Co., of the Elmwood Electrical Works, Leeds, announce that, owing to the rapid increase of their business, they have augmented their manufacturing resources by taking over the general engineering business of Mr. E. C. Wallis, of 1, Bond Place, Leeds, the whole being incorporated into a limited liability company.

O. S. A. Smoking-Concert.—On Friday, 24th inst., the last of the series of smoking concerts given by the Old Students Association was held at Masons Hall Tavern. A most excellent programme was provided, very high class music being given both vocally and instrumentally, while at the same time most excellent humorous selections were given. A vote of thanks was passed to the Musical Committee at the close of the evening for their successful efforts in getting up such an excellent series of concerts.

Aberdeen Royal Infirmary Corporation.—From the minutes of the board of directors of the Royal Infirmary it appeared that the directors had met specially in conference with Professor Andrew Jamieson, of Glasgow, relative to the introduction of the system of electric lighting, the supply of steam for the same, also for cooking and heating purposes, &c., when, after hearing the professor at some length, and having examined a sketch plan showing the accommodation held by him to be essential for the full engineering plant, they unanimously resolved to "instruct the architects, in consultation with Professor Jamieson, to prepare the necessary detailed plans, showing chimney stalk, and to take the required steps for carrying out the work of introducing the electric light, and forwarding all due arrangements for boilers to supply steam for the purposes for which steam is required throughout the new buildings."

Censorship of Telegrams in Germany.—In future no censorship of telegrams will be exercised in Germany except in times of public danger.

The Institution of Electrical Engineers.—On Thursday, May 7th, the following papers will be read:—1. "On some Effects of Alternating Current Flow in Conductors having Capacity and Self-Induction," by Dr. J. A. Fleming, Member; 2. "Some Points connected with Mains for Electric Lighting," by W. H. Preece, F.R.S., Past President.

Central Institution Lectures—Summer Term.—Monday and Wednesday, at 3 p.m., commencing Monday, May 11th. The subjects of Prof. Ayrton's course of lectures at the Central Institution of the City and Guilds of London Institute, and which may be attended by special students, are given below:—The elementary portions of the Theory and Practice of the Electric Distribution of Light and Power with Alternating Currents, Self and Mutual Induction, Phase Difference between Currents and Pressures, Transformers, Construction and Use, Mode of Testing, Safety Devices, High Pressure Mains, Telegraphy and Telephony.

The Inventors' Institute—Cui Bono?—We recently noticed the following in the *Standard*:—"The Inventors' Institute held their evening meeting in the Grand Salon of the Medical Battery Company, in Oxford Street. An explanatory lecture was given by Mr. C. B. Harness, the founder of the Electropathic and Zander Institute. The chairman stated that during the 30 years during which the Inventors' Institute had been in existence the inventions for the application of electricity to medical purposes had never been brought under discussion at any of its meetings. The request for a party of members to be allowed to see both the electrical and mechanical appliances in operation had been met by the liberal offer of the edifice itself as the place of meeting. Some three hundred guests assembled. A general *conversazione* followed the lecture." It is not necessary to congratulate the President of the British Association of Medical Electricians upon this new conquest, but we cannot let the matter pass without remarking that this episode will doubtless add fresh lustre to the name of the Inventors' Institute. To completely reach the highest niche in the temple of fame, it only remains to place its stamp of authority upon a well-known electro-deposition process.

Electrical Papers and the Civil Engineers.—In our issue of April 17th, we dwelt at considerable length upon the most essential points of Mr. Crompton's excellent paper, entitled "The Cost of the Generation and Distribution of Electrical Energy." We then expressed the hope that the subsequent discussions at the Institution of Civil Engineers would bring forth valuable data relating to the cost of electrical energy. Unfortunately, however, this discussion assumed a more or less undignified character; undignified in the sense that it took place in the presence of a generally grave assemblage of civil engineers. Electrical engineers at once took up the crusade of alternating *versus* continuous current distribution; civil and mechanical engineers ventilated their fads relating to engine and boiler construction, and even hydraulic transmission of energy. Three long evenings were thus occupied by speakers, who, with scarcely an exception, misunderstood the drift and object of Mr. Crompton's paper. There was much talk about the efficiencies of transformers, the efficiencies of engines and of dynamos, but no one followed the footsteps of Mr. Crompton, or accepted his challenge to provide detailed working expenses of any central electric lighting station. With one or two exceptions, the recent discussion resolved itself into a chaos of individual opinions and self assertions, without any of the backing which sound, practical figures alone could have justified. If the advocates of the alternating transformer systems have no better arguments than those brought forward at the Civil Engineers, then they had better wait until they are in a position to prove in terms of pounds, shillings, and pence the cost of producing and distributing electrical energy with high tension alternators. We hope, at an early date, to return to this subject, not with a view of commenting upon the empty twaddle to which we listened, but on the promise of some exceedingly interesting data from central stations which bears directly upon the text of Mr. Crompton's contribution.

New York Overhead Wires.—We learn from American contemporaries that Major Grant has again taken the field against overhead wires, and the chopping of poles proceeds apace.

Paris Lighting.—The Paris Municipality on Wednesday renewed for 10 years the contracts for the electric lighting of the Boulevards.

City and South London Railway.—The Lambeth police magistrate ordered the directors to put back the Kennington Park Road Station to a level with the adjoining houses. The Queen's Bench, however, allowed an appeal, but granted permission to the County Council to carry the case further.

Fatal Fall from a Telegraph Pole.—At Ashton-under-Lyne, last Friday morning, a fatal accident occurred to a man named Thomas King, who resided at Guide Bridge. The deceased, who was employed by the Manchester, Sheffield, and Lincolnshire Railway Company, was engaged along with another man named James Kirk in putting new insulators on a telegraph pole near to the Oldham Road Station.

Influenza Among Telephone Operators.—At the end of last week an epidemic of influenza suddenly attacked the operators in the Manchester switch-room of the National Telephone Company, Limited, and, consequently, the service is unsettled. Everything that is possible is being done to meet the serious difficulty by drawing operators from other centres, but, as the service must be temporarily interfered with, the company ask subscribers to exercise forbearance.

Fire at Fowler, Lancaster and Company's Show Room.—A fire occurred at Messrs. Fowler, Lancaster and Co.'s show room and central office in Birmingham on Wednesday, occasioned by a curtain being blown near to the fireplace, and ignited by sparks or by a cinder falling upon it. The show room was completely gutted, and damage done to the amount of several hundred pounds, part only of which is covered by insurance. The fire will not occasion any interference with their business or the execution of orders.

Electric Call Systems.—There is evidently going to be a struggle between the two companies which have recently obtained licenses from the Postmaster-General for the establishment of the electric call system, &c. The District Messenger Service and News Company, Limited, states that it is the only company in Europe having the system in operation, whilst the Boy Messengers, Limited, claims to be the original company established in 1887. No doubt a little healthy competition will be of advantage to the public, but the former company has got a good lead.

Long-Distance Telephony.—Since commenting upon Mr. Hastie's action with regard to the National Telephone Company's London system, we note the following in the Edinburgh *Evening Dispatch* of the 28th :—"We announce to-day that the National Telephone Company has resolved to construct a telephone line between Scotland and England. The two countries are indebted to this telephone company for a large share of the blessings it has, and had it not been for the crass stupidity of Post Office officialism, these benefits would have been far greater. There is, however, something very far wrong when our Post Office is concerning itself with such idle schemes as telephone lines between London and Marseilles, and London and Bordeaux, while all the time scarcely two important towns of Great Britain and Ireland are in telephonic communication with each other."

The Monarch Magnetic Ore Separator.—Those who were present last week at the demonstration given of the capabilities of the "Monarch" magnetic ore separator, were fully impressed with the efficiency of the machine, which has done excellent practical work in the United States. Some of the gentlemen representing technical journals appeared, however, to be grossly ignorant of technical matters, one individual actually asking what "current" was. The result of this is that out of four notices which were published, two of them are proposed to be amplified this week—of course, from the descriptions printed by the other two journals. All things considered, the Press view was not well arranged ; but this should not prevent those journals, which profess to be of a technical character, from giving lucid descriptions.

Electrostatic Inductive Capacity.—With reference to our correspondent's (Mfd.) letter on this subject in our present issue, we would remark that we have, from other sources, had doubts expressed as to the correctness of the assumption that the capacity of a looped aerial wire is one-half that of a single wire when earth is used as a return. The matter certainly requires looking into, and we would invite correspondence on the subject. "Mfd." does not state how he arrives at the result that the "calculated capacity of two well-insulated 4 mm. wires, suspended at a uniform distance of 14 inches apart, is about ·009 mfd. per mile ;" but we imagine he must be taking the case of two wires suspended in *space*, *i.e.*, with no earth in proximity, an incorrect assumption, we believe, to work on in considering the subject theoretically. The inductive capacity of two covered wires, slung side by side in *space*, would not, we think, be the same as that of the two wires similarly immersed in water.

Accidents caused by Electric Lighting at Paris.—In consequence of the extension of the nets for the distribution of electricity in Paris, there have been produced numerous accidents, more or less serious. Two of these accidents have in particular stirred up public opinion—the fire at the Café de la Paix and the explosion of the Rue Royale, at the La rue Restaurant. In consequence of this explosion, a deliberation of the Municipal Council of Paris, under date March 13th, 1891, instructed the administration to draw up a list of the accidents with an indication of the probable causes, and a technical commission will be very shortly nominated to study these accidents, and to decide on the measures to be take for their prevention. The accidents mentioned since September, 1889, are 18 in number. Though the most of them are unimportant it is plain that measures should be taken to diminish their frequency and remove the bad impression occasioned. We shall keep our readers informed of the deliberations and of the decision of the commission.

NEW COMPANIES REGISTERED.

London Electrical Tramways Company, Limited.—Capital £150,000 in £1 shares. Objects : To acquire the tramway system, equipment and undertaking of the North London Tramways Company, as a going concern, together with certain extensions and reparations ; to construct, purchase, lease, lay down or otherwise acquire any tramway in the United Kingdom ; to equip, reinstate, maintain and work by horse, steam, electricity or any other power, the tramways belonging to or leased by the company ; to purchase, take on lease or otherwise acquire, build, construct, repair or improve any lands, houses, stables, engine houses, buildings, steam, locomotive or other engines, cables, wires, lines, electrical generators and accumulators and other electrical apparatus ; and to carry on the business of manufacturers of and dealers in tramway carriages, trucks, locomotive, electrical and other engines, electrical apparatus and plant, and other effects used in connection with tramways. Signatories (with 1 share each) : C. J. Westwood, 3, Adelaide Place, E.C. ; F. C. Winby, 3, Adelaide Place, London Bridge, E.C. ; C. Docrora, 3, Adelaide Place, E.C. ; B. Sanders, Chigwell, Essex ; E. J. Relf, 12, Humber Terrace, Westcombe Park, S.E. ; R. Knights, Wanstead ; A. W. Hurrell, 165, Queen Victoria Street, E.C. The number of directors is not to be less than 3 nor more than 7, the first to be determined by the subscribers. Qualification £100. Remuneration to be determined at the general meeting. Registered on the 22nd ult. by Hurrell and Mayo, solicitors to the company, 165, Queen Victoria Street, E.C. Office, 3, Adelaide Place, London Bridge, E.C.

British Electrolytic Syndicate, Limited.—Capital £100,000, in £1 shares. Objects : To adopt an agreement expressed to be made between F. Bennett of the one part and the company of the other part, to carry on the business of miners, metallurgists, smelters, engineers, merchants, bankers, brokers, shippers, owners, managers, or overseers of railways, tramways, &c. ; to carry on the business of an electric light company in all its branches, of electricians, electrical contractors, electrical and mechanical engineers, of manufacturers of and dealers in all apparatus required for

the generation, distribution, supply, accumulation, and employment of electricity; and to construct, lay down, fix, and carry on all necessary cables, wires, lines, accumulators, lamps, and works. Signatories (with 1 share each): F. Stafford, 2, Garden Court, Temple; T. Lewis, Bangor; W. J. Tippetts, 11, Maiden Lane, Queen Street, E.C.; A. Maclaren, Coatham, Redcar; H. T. Middleton, 8, Princes Street, S.W.; A. C. Hutchins, Drayton Lodge, Ealing; A. J. Jordan, Keymer. The number of directors is not to be less than three nor more than seven, the first to be determined by the subscribers. Qualification, £100. Remuneration, £1,000 and a percentage of the profits divided between them. Registered on the 22nd ult. by the Metropolitan and Provincial Syndicate, Limited, Lonsdale Chambers, 27, Chancery Lane, London, W.C.

Corifact Syndicate, Limited.—Capital £15,000, in £1 shares. Objects: To adopt an agreement, a draft of which has already been prepared and made between W. A. Burrows and J. W. Savage of the one part, and the "Corifact Syndicate, Limited," of the other part, to carry on the manufacture and sale of artificial leather and leather board, electrical apparatus, the covering and insulation of electrical conducting wires and cables, of insulated and other wires for telegraphic, telephonic, and other purposes; and to carry on the business of electricians, engineers, merchants, bankers, shippers, agents, traders, manufacturers, and contractors. Signatories (with 1 share each), L. A. Atherley-Jones, M.P., 4, Paper Buildings, Temple; E. W. Richardson, 50, Finsbury Circus, E.C.; P. Cave, Rushden, Northampton; E. A. Tate, 102, Corbyn Street, Hornsey Rise, N.; R. Stray, 22, Horsford Road, Brixton, S.W.; E. Alabaster, Leadenhall Buildings, E.C.; C. J. Tritton, 87, Florence Road, Finsbury Park. The number of directors is not to be less than three, nor more than seven, the first being the first three subscribers. Qualification, 100 shares. Remuneration to be determined at the general meeting. Registered on the 23rd ult. by J. S. Blanckensee, 35, King Street, Cheapside.

Cuttriss, Wallis and Company, Limited. — Capital £10,000 in £5 shares. Objects: To convert the partnership firm of Cuttriss & Co., of the Elmwood Electrical Works, Camp Road, Leeds, and the business of E. C. Wallis, of 1, Bond Place, Leeds, into a joint stock company; to adopt the agreement mentioned in clause 2 of the articles; to manufacture, buy, sell, hire, let and deal in dynamos, lamps, wire cables, insulating materials, accumulators, telephones, and other apparatus used in connection with the generation, distribution, supply, accumulation and employment of electricity; and generally to carry on the business of electricians and mechanical engineers. Signatories (with one share each): T. Cuttriss, 83, New Briggate, Leeds; S. W. Cuttriss, Camp Road, Leeds; E. C. Wallis, 1, Bond Place, Leeds; W. Greenhalgh, 40, Kirkland Road, Hunslet; A. A. Parsons, 5, New Station Street, Leeds; J. C. Birch, 2, Brunswick Place, Leeds; A. Towler, 31, Bismarck Street, Beeston Hill. The number of directors is not to be less than three nor more than five, the first being T. Cuttriss, S. W. Cuttriss and E. C. Wallis, all of Leeds, electricians, and J. W. Bannister, of Leeds, dyer. Qualification, £150. Remuneration, £50 per annum, divided between them. Registered on the 22nd inst. by Vincent and Vincent, 20, Budge Row, E.C.

Electrical Advertising Syndicate, Limited.—Capital £10,000 in £10 shares. Objects: To acquire all or any patents, or such parts thereof as may be agreed upon, for Upward's method and apparatus for the application of electrical energy to the purposes of advertisements; and to work, develop, exercise and promote the uses of any invention acquired by the company. Signatories (with one share each): J. Hewitt, The Oaks, Dalston, Cumberland; A. J. Semon, 30, Tyers Terrace, Vauxhall, S.W.; J. A. Spailing, 35, Ladbroke Road, Notting Hill; W. J. Newbert, 43, Portman Place, Globe Road, E.; C. Cole, 9, Rosendale Terrace, Leytonstone; A. Copping, 11, Queen Victoria Street, E.C.; G. F. Tucker, 9, Gateley Road, Stockwell, S.W. The number of directors is not to be less than three, including managing director, the first to be appointed by the subscribers. Qualification, 10 shares. Remuneration, £50 per annum. Mr. A. R. Upward is managing director for three years. Registered on the 29th ult. by F. Bradley, 75, Mark Lane, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

The Cambridge University and Town Electric Lighting Company, Limited.—The first annual return of this company, made up to the 28th June, 1890, was filed on the 8th inst. The nominal capital is £50,000 in £10 shares. Seven shares have been taken up, but upon these no call has been made. Office, St. Mary's Street, Cambridge.

The Chagford and Devon Electric Light Company, Limited.—The statutory return of this company, made up to the 1st inst., was filed on the 7th inst. The nominal capital is £2,000 in £1 shares. 449 shares have been taken up, upon 49 of which the full amount has been called, and upon the remainder £1 per share has been considered as paid. The calls paid amount to £49. Office, The Woollen Factory, Chagford, Devonshire.

The Brighton and Hové Electric Light Company, Limited.—The annual return of this company, made up to the 7th inst., was filed on the same day. The nominal capital is £100,000 in £5 shares. 3,000 share have been taken up, upon 1,400 of which the full amount has been called, and upon the remainder £1 5s. per share has been called. The calls paid amount to £9,000, and the amount considered as paid on 1,600 shares is £6,000. Offices and works, Gloster Road, Brighton.

Midland Electric Light and Power Company, Limited.—The annual return of this company, made up to the 8th ult., was filed on the 17th ult. The nominal capital is £50,000 in £10 shares. 3,139 shares have been taken up, upon 7 of which the full amount has been called, and upon the remainder the full amount has been considered as paid. The calls paid amount to £70. Office, 33, Waterloo Street, Birmingham.

Electrical Standardising, Testing and Training Institution, Limited.—The statutory return of this company, made up to the 7th February, 1890, was filed on the 17th ult. The nominal capital is £10,000 divided into 1,900 ordinary and 100 founders' shares of £5 each. Seven shares have been taken up, but upon these no call has been made. No office has been registered.

Electrical Works Construction and Maintenance Company, Limited.—The annual return of this company, made up to the 13th January, 1891, was filed on the 17th ult. The nominal capital is £2,000 in £1 shares. Seven shares have been taken up, but upon these no call has been made. Office, 15, St. Helen's Place, E.C.

River Plate Electricity Company, Limited.—The annual return of this company, made up to the 31st October, 1890, was filed on the 15th ult. The nominal capital is £500,000, divided into 49,900 ordinary shares of £10 each, and 1,000 founders' shares of £1 each. 13,557 ordinary and 892 founders' shares have been taken up, and upon 11,157 ordinary and 892 founders' shares the full amount has been called, while 2,400 ordinary shares are considered as paid. The calls paid amount to £108,850, considered as paid to £24,000, and unpaid to £2,720. Office, 78, Coleman Street, London, E.C.

Miners' Lamp Electric Lighting Company, Limited.—The statutory return of this company, made up to the 25th May, 1889, was filed on the 16th ult. The nominal capital is £3,000 in £5 shares. 255 shares have been taken up, upon 85 of which the full amount has been called, and upon the remainder the full amount has been considered as paid. The calls paid amount to £420, considered as paid to £850, and unpaid to £5.

The first annual return of this company, made up to the 26th September, 1890, was filed on the 16th ult. No change has been made. Office, 118, Albion Street, Leeds.

Birmingham Electric Supply Company, Limited.—The registered office of this company is now situate at 14, Dale End, Birmingham.

International Electric Syndicate, Limited.—The registered office of this company is situate at 5, Guardian Buildings, Manchester.

Electric Wiring and Fittings Company, Limited.—The statutory return of this company, made up to the 24th January, 1890, was filed on the 9th ult. The nominal capital is £5,000 in £1 shares. 2,882 shares have been taken up,

upon 1,382 of which 5s. per share has been called, and upon the remainder the full amount has been considered as paid. The calls paid amount to £343 15s., considered as paid to £1,500, and unpaid to £1 15s. Office, 42, Duke Street, St. James's, London, S.W.

CITY NOTES.

Metropolitan Electric Supply Company.

SIR JOHN PENDER presided at the fourth ordinary meeting of this company, held at Winchester House on Wednesday. Taking the report published in our last issue as read, he said it was desirable that shareholders should clearly understand the position of the company, and how the finances had been dealt with during the last fifteen months. The form in which the accounts was presented was in accordance with the wishes of the Board of Trade, who, under the provisions of the Electric Lighting Act, had power to prescribe the manner in which accounts of companies should be kept. They were, however, informed by the board that they would be content with a detailed account dating from the last balance sheet. The accounts spoke for themselves. Shareholders would be able to form a fair idea of the amount of work which had been carried out, as well as the money expended in order to bring the company to its present position. It was satisfactory to find that the revenue made during the later period of working showed a small profit. Revenue was growing, and the future success was assured. With regard to the interim dividend, he was glad to tell the shareholders that the period since showed an actual increase, although it was comparatively bright weather. The small dividend announced proved that the anticipations which the directors held out at previous meetings were in a fair way of being fulfilled. It would be interesting for them to compare the commencement and close of the period of the company's existence. In 1889 they had opened the first portion of Sardinia station, and had a few temporary overhead wires to customers. Rathbone Place had been running a short time, the erection of Manchester Square had not even commenced, Whitehall station was then as at present doing good and steady work, and the total number of lamps on the 1st October, 1889, was 6,011, to-day it was 60,000. Customers then numbered 37, they now amounted to 480. As the report also showed, their revenue for 1889 £2,656, in the corresponding period of 1890 £10,726. The plant at Sardinia Street had been duplicated, the new plant at Rathbone Place installed, and a network of underground mains. Applications for the light were steadily growing, and he fully believed that at the next meeting they would be able to report that the lamp connections numbered 100,000 lights, if not considerably more. They must understand that the whole of this increase would be amply dealt with by the present machinery, and therefore if they could show a profit on 50,000 lights, they ought to be able to show a much larger profit when supplying 100,000 lights. They would see from a diagram on the wall that very much remained to be done before they had completely lighted their district. He would like to make a few remarks as to the choice they had made in their system. It was mainly the alternating current transformer system, which they worked at the extremely moderate pressure of 1,000 volts. They adopted it under the very best scientific advice, and they were perfectly satisfied with the results of the choice. It enabled them to cover the area of supply at less cost than any other system, and they would remember that he told them at the first meeting that they had not put all their eggs into one basket. They had different installations, and those installations would work alone or together, and that had been proved to be the fact. The system had turned out in America to be a most profitable one, and he thought they were going to prove it most profitable in England. The advocates of other systems had been lately doing their best to disparage the merits of the alternating current, and endeavoured to make a strong point out of the loss of energy which, to a certain extent, undoubtedly occurred in connection with the transforming apparatus, but he would remind them that that loss was insignificant when compared to the heavy initial outlay which the use of the continuous current necessitates. He would, moreover, point out that any loss would be reduced to a minimum so soon as the increasing density of the lighting warrants the establishment of transformer sub-stations. This question of transformer sub-stations, or, as the Americans say, of banking transformers, had for a long while been receiving their careful attention, and they all along had in view their ultimate adoption as soon as the business was sufficiently developed to ensure their being worked economically. Another great advantage of the system over all others adopted in London was that each of the alternate current stations can assist, or be assisted, by any other—indeed, it is the usual practice at present to shut down one of the stations entirely during the hours when the load is lightest; and during the summer it was quite possible that one station would be adequate to deal with the requirements of the whole of the areas during the hours of minimum demand, thus gaining considerable economy in working. In speaking to them of systems of supply, they would probably have in their minds that adopted by another great London supply company. They must all admire the indomitable pluck with which the difficulties, inseparable from the achievement of such a scheme, had been faced; they must all admit the genius of the engineer who was responsible for such a gigantic design, and most heartily did he wish him success, and they must acknowledge the accustomed skill displayed by his friend, the chairman of that company, in his recent review of their position and prospects. They sincerely trusted that not only for their own sake, but for the sake of the cause of electric lighting generally, their success was now assured, and they were glad to think that they were able to be of some assistance to them in their hour of need. But as the chairman could not avoid attempting to make a point at their expense in dealing with the anticipated immunity from vibration difficulties, so he ventured to repeat the friendly warnings which he had often uttered before—namely, that it is dangerous to put all their eggs in one basket. One of the principal arguments brought by the London Corporation in establishing one large central station outside London, was based on the fact that the Gas Light and Coke Company had done the same at Becton, and, what the Gas Company did after 50 years and more working on a more modest scale, their friends had done after three or four years of purely pioneering work. Of the two examples, the Metropolitan preferred to follow that of the former, and to walk before they ran. When their figures can show something like the returns of the Gas Light and Coke Company, with its 200,000 customers and its million tons of coal, which was yearly required to meet the demands upon them, then would be the time to consider whether economy and efficiency would best be served by the erection of a great outlying generating station, or whether their present policy of smaller plants which could render one another mutual assistance, thus reducing the risk of failure of supply to a minimum, would even then be the soundest one. With regard to vibration, to which Mr. Forbes had referred, it was, of course, inevitable that the erection of large machinery works in the midst of a great town should give rise to complaints. They had, of course, had to deal with grievances respecting ancient lights, alleged noise, and what not, about which he would say more but for the fact that they had at present two cases *sub judice*. He might say, however, that every precaution had been taken to prevent the possibility of any noise or vibration occurring, and as a practical proof that such precautions could be taken with success, he would inform them that they were now sitting within a very few yards of a powerful plant which was working at that moment, and which supplied the electricity and other requirements for the whole building. There was one other point in Mr. Forbes's remarks to which he would allude. In answer to a question respecting the amount receivable per lamp per annum, he had replied that £1 per light "was not enough, and that his corporation would now refuse to take a contract at such a rate." If this applied to their customers as a whole, he must congratulate the London Corporation on their experience, which was quite at variance with that of themselves, or, he might safely add, of any other London supply company. There were, he admitted, classes of customers with whom a contract on such terms would be out of the question, whose consumption would need a far larger contract price than 20s. But against these classes had to be set the private customers, whose demands on their supply were comparatively small, and from whom it would be impossible, and, indeed, unfair, to obtain so high a price per light. He was speaking now of experience gained by the supply of current by meter, by which means the larger proportion of their customers were now charged. The average revenue obtained for each 8 C.P. lamp connection per annum was about 12s., and he believed that even this figure was a better one than was obtainable by companies whose area of supply was of a more purely residential character than their own. They must not think that they were losers by this experience. The less each lamp was used the greater the number of lamp connections the plant could safely deal with. They were, therefore, able to supply a far larger number of lights than he had originally believed the plant capable of meeting, and hence their operations were considerably widened, and they would gain by number what they had lost by rate. With regard to their system of underground mains, the length of conduits at present laid amounted to 40 miles. The whole of this work had been executed under the immediate supervision of their own staff, and by their own workmen—a more efficient and economical plan than that of employing a contractor. Into these conduits they had drawn 90 miles of mains, and it was a matter of deep satisfaction for him to inform them that not one single fault or leakage had yet occurred in any one of their circuits. Anyone who realised what this meant, would readily agree as to the excellence of the cable employed, and to the skill and care with which their staff had manipulated it. It also tended to strengthen their conviction that the system adopted for their mains was the proper one. They had always made it a practice to give a constant supply, night and day, and although, at any rate at first, and during the small hours of the night, the demand had scarcely justified them in doing this from an economical point of view, they had, nevertheless, always believed it to be their first duty to honourably carry out the responsibilities which had been imposed upon them by their Parliamentary obligations, and to prove to their customers that electric lighting was, no less than gas, reliable whenever wanted. With regard to their Paddington concession, granted last August, they were already making great progress in this district with their mains, and were already supplying upwards of 2,000 lights from their Manchester Square station. Indeed, had it not been for the exceptionally severe winter, which stopped their works for at least two months, their progress would have been still more marked. The large demand for light in this important parish rendered it necessary for them to proceed at once with the erection of a station on the wharfside premises which they had acquired, and as the bulk of the machinery was already completed, and the building works to be commenced in a few days' time, they had every reason to believe that the station would be completed in time for next winter's lighting. As far as they could at present estimate, the erection of this station, with the supply mains and the completion of the present system in their other districts, would, as nearly as possible, absorb their present issue of capital. They would therefore soon issue notices for the payment of the final call of £1 per share, and he thought they would be meeting the wishes of the shareholders in this respect, as there would then be no further liability on the shares, which would, therefore, improve their already

favourable position on the market, and would tend to add to their attractiveness as a sound investment.

The motion, which was seconded by Sir GEORGE ELLIOT, M.P., was carried unanimously.

The retiring directors and the auditors were then re-elected, and the usual vote of thanks to chairman and directors concluded the meeting.

The Kensington and Knightsbridge Electric Lighting Company, Limited.

THE report of the directors, to be presented at the fourth ordinary general meeting, to be held at No. 1, Great George Street, Westminster, on Monday, the 4th day of May, 1891, at 5 p.m., reads as follows:—

The directors beg to submit to the shareholders a statement of the accounts of the company, together with a report of the position of the undertaking at the end of the year 1890.

The whole of the compulsory area has had its streets, with the exception of about three-quarters of a mile, supplied with mains, and in 2½ miles of streets, external to this area, mains have also been provided, making the total length of streets down which mains have been placed, 10 miles, about four miles of which have been executed in the year 1890. It is computed that there are about 1,300 houses fronting on these mains, and on the 31st December last only 291 were taking current. During the year the number of houses and shops connected with the system has increased from 147 on 31st December, 1889, to 291 on 31st December, 1890; while the number of lamps calculated on the usual basis of 8 candle-power has increased from 11,794 to 25,535.

The battery station in Queen's Terrace Mews, which was in the course of construction at the time of the last report, has now been completed and at work for some months with most satisfactory results. The plant at both Kensington Court and Chapel Place stations has been increased, not only to meet the extra lighting obtained during the year, but also to provide power for a large increase of demand. It may be found, however, that the demand will increase with sufficient rapidity to necessitate the execution during the current year of larger extensions than the company's present funds would enable them to provide. To guard against such a contingency the directors think it would be well that they should be in a position to issue some further preference shares, those of the first issue having been already taken up, with the exception of about £2,000. They will therefore submit to the shareholders the requisite resolution for creating further preference shares, the date and conditions of their issue being left to be determined by the directors when the money is wanted.

The dividend on the 6 per cent. preference shares was duly paid to the 30th June, 1890, and out of the balance standing to the credit of the nett revenue account on the 31st December, 1890—£1,804 2s. 2d.—the sum of £922 18s. 3d. has been appropriated for the payment of the preference dividend to that date, leaving £881 3s. 11d. available for the next account.

Sir Charles Grant retired from the directorship during the year, and Mr. George H. Hopkinson was appointed by the directors to fill the vacancy.

In accordance with the articles of association, Mr. Granville R. Ryder and Mr. R. W. Wallace retire from the directorship, and being eligible offer themselves for re-election.

The auditors, Messrs. Lovelock H. W. Whiffen and Dickinson, offer themselves for re-election.

By Order of Board,
R. S. ERSKINE, *Secretary.*

April, 1891.

BALANCE SHEET, 31st December, 1890.

Dr.		£ s. d.
To capital, 15,000 ordinary shares of £5 each ...		75,000 0 0
„ „ 7,680 1st preference shares of £5 each ... ... =	£38,400	
Less calls in arrears	1,750	
		36,650 0 0
„ Sundry creditors on bills payable, and open accounts		14,991 10 4
„ Renewal account, balance at credit thereof ...		1,398 14 1
„ Net revenue account		1,804 2 2
		£129,844 6 7

Cr.		£ s. d.
By Plant, buildings, mains, furniture and fittings, provisional orders and goodwill		117,828 11 6
„ Freehold and leasehold property ...	£5,307 7 1	
Less depreciation	85 14 2	
		5,221 12 11
„ Preliminary expenses		623 12 11
„ Sundry debtors		4,256 12 11
„ Stock in trade and stores		437 9 4
„ Consols		549 3 10
„ Cash at bankers, Messrs. Hopkinson	£633 5 3	
„ „ „ London and County Bank	290 2 0	
„ „ in hand	3 15 11	
		927 3 2
		£129,844 6 7

REVENUE ACCOUNT for the year ending 31st December, 1890.

Dr.	£ s. d.
To Manufacturing electricity, coal, oil, water, waste, wages, and sundries	2,915 8 8
„ Repairs to leasehold property	2 13 8
„ „ Apparatus to consumers' premises ...	8 19 4
„ Incandescent lamps	228 0 7
„ Salaries	723 11 6
„ Miscellaneous expenses, including law charges and auditor	353 19 5
„ Rent and taxes	731 15 6
„ Insurance	56 4 0
„ Renewal account, sundry various percentages on buildings, mains, plant, batteries	1,823 12 8
„ Sinking fund	85 14 2
„ Balance	1,404 14 8
	£8,334 14 2

Cr.		£ s. d.
By Sales of electricity	£7,865 5 2	
Less rebates	156 10 11	
		7,708 14 3
„ Rent of meters		265 0 1
„ Repairs to apparatus on consumers' premises ...		10 9 5
„ Sale and maintenance of lamps		226 15 5
„ Rent receivable		123 15 0
		£8,334 14 2

NETT REVENUE ACCOUNT.

Dr.	£ s. d.
To Dividends at the rate of 6 per cent. per annum on preference shares, June 30th, 1890	385 6 6
„ Balance	1,804 2 2
	£2,189 8 8

Cr.	£ s. d.
By Balance from last account	778 6 1
„ „ brought from revenue account	1,404 14 8
„ Interest	6 7 11
	£2,189 8 8

RENEWAL ACCOUNT.

Dr.	£ s. d.
To Maintenance of plant, buildings, mains, meters, instruments, &c.	974 2 5
„ Balance as per balance sheet	1,398 14 1
	£2,372 16 6

Cr.	£ s. d.
By Balance from last account invested in consols ...	549 3 10
„ Amount brought from revenue account	1,823 12 8
	£2,372 16 6

We have examined the above accounts and certify that they are correct, and agree with the books, and that in our opinion the balance-sheet is properly drawn up and exhibits a true and correct statement of the company's affairs.

LOVELOCK H. W. WHIFFEN & DICKINSON,
Chartered Accountants, Auditors.

19, Coleman Street, London, E.C.,
February 18th, 1891.

Indo-European Telegraph Company, Limited.

THE twenty-fourth ordinary general meeting of this company was held on Tuesday last at Winchester House to consider the directors' report and accounts for the year ended 31st December, 1890, as also a resolution making the managing director a member of the board.

The reading of the notice convening the meeting and the taking the report and accounts as read being gone through,

The Chairman (Mr. J. HERBERT TRITTON) said: They would observe from the report that the receipts of the company showed an augmentation of £5,518 over those of 1889, being £113,807, while the gross expenses were £57,901, a decrease of £1,338 from those of the previous year. There was an increase of £2,000 in the maintenance expenses, owing to the depreciation in value of the rouble—the basis upon which the company's payments were made—and a loss of £420

on the commercial account arising from the same cause. Notwithstanding this adverse circumstance, they had carried £10,000 to reserve, recommended the payment of dividend and bonus, making up 10 per cent., and carried forward £4,168, as against £2,035 for 1889. The company had again expended considerable sums in the strengthening of lines, and in removing a long length of line from the high road along which it formerly ran to the side of a railway, where it was more protected from disturbance. Indian traffic, both their own and the Eastern Companies, had shown at last some elasticity, there being an increase, as compared with 1889, of £9,904, of which the company's share was £2,739. The income from this source had not yet reached the amount of the receipts in 1885, the year preceding the reduction of tariff, the gross receipts being less by £55,876, and the company's by £13,494 than in that year; or taking the year 1886, on the 1st of July of which year the reduction came into force, the gross receipts from Indian tariff were less by £35,727, and the company's by £7,982. The traffic appeared now to have taken a turn for the better, and might work up to something like the old figures. Of course it depended mainly upon the state of trade. The service had been such as to give unqualified satisfaction to their customers, the working of the lines, both of the company and the Indian Government, having been excellent, and distinct service had been rendered to the commerce of India and Australia, by the complete efficiency of the lines, both the Government's and the company's from end to end. They would have learned from the newspapers that the perseverance and energy of Sir John Pender had succeeded in bringing about an arrangement with the colonies of Australia for the introduction of a low rate for messages between Europe and Australia, any loss that might occur being borne half by the colonies and half by the company and Indian Government. This large measure had been a work requiring conciliatory views and careful consideration on the part of several important interests. Their own company, for instance, had to obtain the consent of Germany and Russia. The German Postmaster-General, his Excellency, Dr. von Stephan, had long been recognised as a leader in telegraphic reforms, and had consented at once, and the Russian Director-General of Posts and Telegraphs, His Excellency General von Besak, had consented on behalf of Russia. The Indian Government, through Sir Juland Danvers, this company through its managing director, the Eastern and Eastern Extension Companies, and the colonial representatives were all engaged in the work, and at last the difficulties were all surmounted, and the reduction would begin from the 1st of May next. The results of lowering the Indian tariff were not encouraging as an introduction to the reduced Australian rates, but the circumstances were not quite the same. The Australian communities were growing enterprising and active to an extraordinary degree. They were our own kith and kin, and if the introduction of low rates to such communities did not succeed, all he could say was that the experiment had been tried under the most favourable possible circumstances, and he hoped and believed it would be a success. Whether an experiment which was only enforced for a year would have sufficient time to be thoroughly worked and examined was a question, but he could not but believe that every method of reducing the cost of communication with our own kith and kin around the world deserved, to say the least, a careful and patient experiment. The traffic with these colonies had continuously shown an increasing tendency, and, apart from the reduction, there would have been an increase which the reduction ought materially to accelerate and increase. The chairman concluded by moving that the report and accounts be accepted, and that a dividend for the six months ending December 31st of 17s. 6d. per share, making, with the dividend already paid, 6 per cent. for the year, and a bonus of 20s. per share, both free of income tax, and making in all 10 per cent., be paid.

Mr. H. WEAVER seconded.

Captain JACKSON said the reduction of rates to Australia was nothing extraordinary. A telegram could be sent 7,000 miles across the Atlantic and the North American Continent to the Pacific for 1s. 6d. They had been charging 9s. for a line that was only 3,600 miles long, about half the distance. Of course, he would be met by the statement that there was in the one case an enormous business, and in the other a comparative paucity, but India was an enormous community, and if it was desired to encourage and develop traffic, he trusted that the 4s. rate would never be receded from. He was glad to see that Sir John Pender had awakened to the fact that monopoly would not do in these days, and that the Eastern Telegraph might meet with a competitor as the Western Telegraph had done. He hoped they would go on reducing the tariff rather than recede from the reduction already made.

The CHAIRMAN said that any comparison between messages sent to San Francisco and those sent to Australia was likely to be misleading. They had to bear in mind the comparative length of land lines and cables involved the initial cost of deep sea cables being much greater than that of land lines.

The resolution was then put and unanimously carried.

The Chairman, who was retiring by rotation along with Major-General G. B. Tremenheere, having vacated the chair,

Mr. EARLE moved, and Mr. HOLLAND seconded, that these gentlemen be re-elected to the board of directors.

This was done.

On the motion of Messrs. Wills and Woodman, Messrs. Kemp, Ford & Co. were re-appointed auditors at a remuneration of 100 guineas.

The CHAIRMAN then moved the resolution making the "managing director of the company a member of the board, having all the privileges, and being subject to all the obligations of an ordinary director, except that he should not receive extra remuneration as a director, nor retire from office by rotation." He said that moving this resolution gave him considerable satisfaction. Few men had done more for the companies they represented than Mr. Andrews had done for the Indo-European.

Captain JACKSON said it was due from the shareholders to state that 21 years' management of this company had placed it in an exceptional position as a telegraph company. A large part of his income was dependent upon telegraph securities, and this company was a most gratifying exception as to the returns made for money invested. Twenty-one years' experience had entitled Mr. Andrews to the confidence of the board and the gratitude of the shareholders, and he thought it quite proper that an expert should be on the board. He, however, objected very strongly to pluralism in directors, and he wished to know whether there was likely to be any embarrassment arising from his having too many engagements.

The resolution having been put and carried unanimously,

Mr. ANDREWS returned thanks, and said that the work he did for other companies was of a similar kind to that he did for the Indo-European, and that it added to the experience and usefulness of a man to widen his survey so long as it was confined to the direction which had been the business of his life. The duties he had to perform did not in any way interfere with the performance of the obligations which he had to this company, and which had for 21 years been performed to the satisfaction of Mr. Jackson and the other gentlemen before him.

A vote of thanks to chairman and directors concluded the meeting.

The Brazilian Submarine Telegraph Company, Limited.

THE report of the directors for the half-year ended 31st December, 1890, to be submitted to the thirty-fifth ordinary general meeting, May 6th, 1891, states that the directors submit the annexed accounts and balance sheet for the half-year ended December 31st, 1890.

The revenue for this period amounted to £143,363 13s. 1d., and the working expenses to £18,106 2s. 9d. After providing £12,880 for debenture interest and sinking funds, and £1,960 11s. for income tax, there remains a balance of £110,416 19s. 4d; to this is added £2,416 18s. 1d. brought forward from June 30th last, making a total of £112,833 17s. 5d. First and second interim dividends amounting to £39,000 have been paid, and £50,000 transferred to the reserve fund, leaving the sum of £23,833 17s. 5d. to be carried to the next account. Of this amount the directors intend distributing £13,000, or 2s. per share to the shareholders, in addition to the usual quarterly dividend of 3s. per share, payable on June 24th next.

The receipts for the half-year include the sum of £1,500 dividend to June 30th, 1890, on the company's shares in the African Direct Telegraph Company, Limited.

The directors deeply regret that the Right Hon. Viscount Monck, who has occupied the position of chairman of the company since its formation in 1873, and Sir Thomas Fairbairn, Bart., who has been a director since 1874, desiring to reduce their engagements, have resigned their seats on the board of the company.

The board have elected Sir James Anderson chairman of the company.

The vacancies on the direction created by the retirement of Viscount Monck and Sir Thomas Fairbairn, Bart., have been filled by the board by the appointment of Lord Sackville Arthur Cecil and Mr. John Denison Pender.

A serious fault appeared in the 1874 cable, about two miles off Lisbon, on the 18th December, 1890, which was repaired by the Telegraph Construction and Maintenance Company's ss. *Britannia*. The same cable was reported interrupted about 18 miles from Madeira on the 7th January, 1891. Arrangements were immediately made for the despatch of the Telegraph Construction and Maintenance Company's ss. *Scotia*, and the necessary repair was accomplished after laying in 25 knots of new cable. The cost of effecting these repairs will appear in the accounts for the current half-year.

The shore-end of the Lisbon-Madeira 1882 cable broke on the 8th March, 1891, close to Madeira. The directors have much pleasure in stating that this cable was effectively repaired by the company's Madeira staff.

Neither of the foregoing operations caused any interruption to the transmission of messages, the traffic having been carried by the duplicate cable.

In accordance with the provisions for repayment of the first issue of debentures, dated July 31st, 1884, 160 bonds representing £16,000 were drawn on the 24th instant, for payment at par on 31st July next. This, with the previous drawings, will make a total repayment of £96,800, leaving £53,200 of the first issue of debentures outstanding.

The various sections of the company's line are in good working order.

ABSTRACT OF ACCOUNTS for the half-year ending 31st December, 1890.

Dr.	£	s.	d.
To General expenses in London	2,371	6	7
„ Working expenses at stations	11,266	5	3
„ Engineers' remuneration	150	0	0
„ Directors' remuneration	1,250	0	0
„ Auditors' fees	50	0	0
„ Insurance of spare cable	12	15	0
„ Staff endowment insurance	262	8	4
„ Special legal expenses	907	19	3
„ Depreciation in value of stock of spare cable ...	1,835	8	4
„ Debenture interest and sinking funds	12,880	0	0
„ Income tax	1,960	11	0
„ Balance down	110,416	19	4
	£143,363	13	1

Cr.	£	s.	d.
By messages	141,243	2	5
„ Interest	583	15	8
„ Transfer fees, &c.	36	15	0
„ Dividend on shares in the African Direct Telegraph Company, Limited, to 30th June, 1890...	1,500	0	0
	£143,363	13	1

Dr.	£	s.	d.
To Interim dividend of 1½ per cent., paid 23rd December, 1890	19,500	0	0
„ Interim dividend of 1½ per cent., payable 25th March, 1891	19,500	0	0
„ Amount transferred to reserve fund	50,000	0	0
„ Balance carried forward	23,833	17	5
	£112,833	17	5

Cr.	£	s.	d.
By Balance brought down	110,416	19	4
„ Balance of revenue account brought forward from 30th June, 1890	2,416	18	1
	£112,833	17	5

RESERVE FUND, 31st December, 1890.

Dr.	£	s.	d.
To Balance carried forward	408,087	18	5
	£408,087	18	5

Cr.	£	s.	d.
By Balance, as per balance sheet, 30th June, 1890...	352,626	2	11
„ Amount transferred from revenue account to 31st December, 1890	50,000	0	0
„ Interest on investments £5,678 18s. 10d., less amount credited to sinking funds (£217 3s. 4d.)	5,461	15	6
	£408,087	18	5

BALANCE-SHEET, 31st December, 1890.

Dr.	£	s.	d.
To Capital—130,000 shares of £10 each	1,300,000	0	0
„ Debentures at 5 per cent.:—First issue, £150,000; less drawn for repayment (£80,800)... ...	69,200	0	0
„ Second issue	75,000	0	0
„ Reserve fund	408,087	18	5
„ Debenture sinking funds	100,118	15	0
„ Bills payable	165	0	11
„ Traffic and other credit balances...	15,613	12	3
„ Debenture holders for bonds drawn for repayment	2,800	0	0
„ Unclaimed interest	1,201	13	9
„ Interest accrued	1,441	13	4
„ Proprietors for unclaimed dividends	5,285	1	0
„ Dividend of 1½ per cent. to 31st December, 1890, payable 25th March, 1891	19,500	0	0
„ Revenue account—undivided profits, 31st December, 1890	23,833	17	5
	£2,022,247	12	1

Cr.	£	s.	d.
By Capital expended as per last account	1,443,653	2	9
„ Spare cable valued at	16,511	0	0
„ Shares in the African Direct Telegraph Company, Limited, at cost...	75,000	0	0
„ Investments	345,754	0	8
„ Bills receivable	7,539	2	10
„ Remittances in transit	412	12	9
„ Traffic and other debit balances	92,411	12	3
„ Cash balances at stations	470	7	1
„ In London—current accounts	16,474	9	4
„ Deposit account	24,000	0	0
„ Petty cash	21	4	5
	£2,022,247	12	1

Reuter's Telegram Company, Limited.

The following is the report which was read at the twenty-seventh ordinary general meeting of the shareholders, held at the Company's offices, No. 24, Old Jewry, on Wednesday last:—The directors beg to report that the net profits for the year ending 31st December last, after payment of directors' remuneration, current expenses, and deducting rebate on unexpired subscriptions, amount to £4,594 7s., including £113 4s. 6d. brought forward from the last account. An interim dividend of four shillings per share was paid in October last, and the directors now recommend a further dividend of four shillings per share, making a total distribution for the year of 5 per cent. free of income tax. This will absorb £3,691 2s. 6d., and leave a balance of £903 4s. 6d. to be carried forward. The dividend warrants will be payable on the 2nd May next. The High Court has sanctioned the alteration of the memorandum of association, enabling the Company to undertake advertisement business, and otherwise to enlarge the scope of its operations. Active measures are being taken to give effect to this extension of the Company's powers. In conformity with the articles of association, Baron de Reuter retires from the direction, but offers himself for re-election. Mr. George de Reuter and Mr. Frederick J. Griffiths have been appointed directors. Messrs. Welton, Jones & Co. offer themselves for re-election as auditors.

The 27th ordinary general meeting of this company was held at its offices in the Old Jewry, on Wednesday last. Sir John Hay was in the chair. The secretary read the notice convening the meeting, and afterwards the report. In moving the adoption of the latter, the chairman said that the revenue when compared with the previous year showed a substantial increase, but the expenditure had also been considerably augmented. Their efforts to maintain their service in the highest efficiency were generally appreciated by the Press, and they would certainly not suffer in the long run from any exceptional or temporary sacrifice they might make to attain the efficiency and accuracy which distinguished their agencies. Roughly speaking, the telegraphic outlay had been £5,000 in excess of 1889, which alone was sufficient to account for the slightly diminished dividend. In these times 5 per cent. was a fair return for capital invested, and as they carried forward nearly £1,000, the shareholders should feel they had reason to be satisfied. The High Court had sanctioned the necessary modification in the memorandum of association, and they had been able to commence the advertisement business. This business they anticipated would eventually yield large profits, and they had opened a separate office for it in the immediate vicinity. Shareholders must not expect to realise large returns at once, but no great pecuniary risk was involved, and if they did not at once obtain large profits they had not to fear losses; indeed, the extra current and preliminary expenses incidental to starting their new business would be the only fresh outlay to provide against. Mr. George de Reuter and Mr. Frederick J. Griffiths had joined the board as directors. As director of the Bank of Persia, Mr. de Reuter had shown businesslike abilities of no ordinary character, and Mr. Griffiths, by 25 years' service as secretary, had made himself master of the details of the business. After his long service he had a perfect right to devolve his arduous duties upon his successor, Mr. Bradshaw, and they were fortunate in securing his knowledge and services as an associate in the direction.

The report was unanimously adopted, and Baron de Reuter, who was retiring by rotation, was re-elected, as were also Messrs. Welton, Jones & Co., the auditors.

Mr. KEELYSIDE, a shareholder, complained that no reference had been made in the chairman's speech to the proposed increase of capital, and Sir JOHN HAY replied that full particulars had been given at the general meeting held in December last.

Mr. KEELYSIDE moved a vote of thanks to chairman and directors. This was carried unanimously, and the chairman's reply concluded the meeting.

The Western & Brazilian Telegraph Company, Limited.—The Board have decided, after placing £20,000 to the reserve fund and £5,936 to the debenture redemption fund, to recommend at the forthcoming meeting a dividend of 9s. per share, free of income tax, making with the interim dividend paid in November last a distribution of £5 per cent. for the year 1890, carrying forward £6,070 to 1891.

Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited.—On Monday last an extraordinary general meeting was held—Mr. F. L. Rawson in the chair—when the resolution which was passed at the meeting of the 6th inst., and which allows dividends to be paid with shares in the French and Austrian Companies instead of cash, was unanimously confirmed.

The Swan United Electric Light Company, Limited.—The directors have resolved to pay an *ad interim* dividend at the rate of 6 per cent. per annum for the half year ending 31st March, 1891, to be distributed in accordance with the articles of association.

Eastern Telegraph Company, Limited.—The directors announce the payment by warrant on the 1st May next of interest for the half-year ending the 30th April on their four per cent. mortgage debenture stock.

The Submarine Cables Trust.—In their annual report the directors recommend a distribution of £1 on account of the coupon due on the 15th instant, in order to pay which a small amount will have to be taken from the current year's revenue.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the past week amounted to £5,998.

The City and South London Railway Company. Traffic receipts for the week ended April 26th, were £784.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 24th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company, were £4,726.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (April 23.)	Closing Quotation. (April 30.)	Business done during week ending April 30, 1891. Highest.	Lowest
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	101	...
1,381,380*l*	Anglo-American Telegraph, Limited	Stock	47 - 48	46½— 47¼xd	48	46½
2,809,310*l*	Do. do. 6 p. c. Preferred	Stock	84½— 85½	84 — 85 xd	86	84
2,809,310*l*	Do. do. Deferred	Stock	11 — 11½	11¼— 12	12	11⅞
130,000	Brazilian Submarine Telegraph, Limited	10	11½— 12	11½— 12	11⅞	11½
84,500*l*	Do. do. 5 p. c. Bonds	100	100 —103	101 —104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	104 —108	...	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	2¼— 2½	2¼— 2½	2 9/16	2 7/16
63,416	Do. do. Non cum. Preference, Nos. 1 to 63,416	2	1⅝— 1¾	1⅝— 1¾	1 13/16	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	5½— 6½	5½— 6½	...	...
$7,216,000	Commercial Cable, Capital Stock	$100	108 —110	108 —110	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	7/16— 9/16	7/16— 9/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	4½— 5½	4 — 5	...	...
16,000	Cuba Telegraph, Limited	10	10¼— 11½	10½— 11½	10⅞	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	16 13/16	16⅝
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¾— 4¼	3¾— 4¼	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10¼— 10⅜	10 — 10¼xd	...	...
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅛— 14⅜xd	14⅛— 14⅛	14 7/16	14⅛
70,000	Do. 6 p. c. Preference	10	15¼— 15⅜xd	15¼— 15⅜	15½	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	108 —111	106 —109 xd	109	108
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅜— 15¼	14⅜— 15¼	15¼	14⅜
91,800*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	...	...
325,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	107	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	105 —108	105 —108	...	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	103½	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —101	99 —101	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5 — 6	5 — 6	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½— 5	4½— 5	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1⅜— 1⅝	1⅜— 1⅝	...	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅜— 3¼	2⅜— 3¼	2⅜	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1 — 1½	1 — 1½	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 only paid)	5	2½— 3½	2½— 3½	2½	...
180,227	Globe Telegraph and Trust, Limited	10	9½— 9⅝xd	9½— 9⅝	9⅝	9½
180,042	Do. do. 6 p. c. Preference	10	14⅜— 15	14⅜— 15⅛	15⅛	14 5/16
150,000	Great Northern Tel. Company of Copenhagen	10	17½— 18	17⅜— 18¼	18	17⅛
230,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	104 —107	105 —108	...	...
9,334*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	10 — 11	10 — 11	...	...
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	18½— 19½	18½— 19½	19¼	18⅜
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	42 — 44	43¾	42¾
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	7½— 8½	7½— 8½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9½— 9⅝	9½— 9⅝	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7½	7 — 8	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	105 —108	106 —109	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	9 — 9½	9 — 9½	9⅜	9⅛
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	4¼— 4½	4¼— 4½	4 7/16	4¼
15,000	Do. 6 p. c. Cum., 1st Preference	10	13 — 13½	13 — 13½	13	...
15,000	Do. 6. p. c. Cum. 2nd Preference (£8 only paid)	10	10 — 10½	10 — 10½	...	...
350,000	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	102 —104	102 —104	103⅜	103
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼— ⅜	¼— ⅜xd	...	...
9,000	Reuter's Limited	8	8¾— 9¼	8¾— 9¼	...	...
209,750	South of England Telephone, Limited, Ordinary Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	⅛— ¼	⅛— ¼	...	...
20,000	Do. 6 p. c. Cum. Prof., Nos. 1 to 20,000 (£3½ only paid)	5	3 — 3½	3 — 3½	...	...
3,381	Submarine Cables Trust	Cert.	113 —118	115 —120	11	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4⅜— 5¼	4⅜— 5¼	...	...
37,350	Telegraph Construction and Maintenance, Limited	12	45 — 47	45 — 47	47	46¼
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	2½— 3½	2½— 3½	...	...
146,128*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	...	...
290,900*l*	Do. do. do. 5 p. c. Debentures	100	98 —101	98 —101	98	...
30,000	West Coast of America Telegraph, Limited	10	2½— 3½	3 — 4	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	92 — 97	95 — 100	100	...
64,174	Western and Brazilian Telegraph, Limited	15	12 — 12½	12½— 13	13	12⅝
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6⅝— 7¼	6⅝— 7¼	7 1/16	6⅞
27,873	Do. do. do. 5 p. c. Deferred	7½	5¼— 5⅝	5½— 6	5 15/16	5⅝
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	...	...
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	3⅛— 3⅜	3⅜— 3⅝	3 11/16	3¼
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11⅝— 12	11⅝— 12¼	12	11¼
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	11½— 12¼	11½— 12½	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
175,100*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —104	100—104	...	..
42,853	*Westminster Electric Supply Corporation, Ord., Nos. 101 to 42,953	3	4⅞— 5⅛	4⅞— 5⅛	4 15/16	...

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7¼—7⅜.—City of London Electric Lighting (Pioneer), Shares of £50, £25 paid, 32—34.—Elmore's Austrian Copper Depositing, 15s., 25s.—Elmore's Priorities, 3⅞—4¼.—House to House Company (£5 paid), 4⅜—5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 2⅛—2⅜.—Manchester Edison and Swan Company, £9 (£1 paid) 2s 6d.—5s.—St. James's and Pall Mall Electric Light £5, 5⅞—6⅛.—St. James's and Pall Mall, 7 per cent. pref., ⅜ to ½ prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2⅜—2⅞.—Preference, fully paid 3⅞—4⅜.—Debentures 90—95.—Woods Electric Car, £10 paid, ⅜—1.

BANK RATE OF DISCOUNT.—3½ per cent. (16th April, 1891).

ON VARIATIONAL ELECTRIC AND MAGNETIC SCREENING.*

BY SIR W. THOMSON, P.R.S.

1. A SCREEN of imperfectly conducting material is as thorough in its action, when time enough is allowed it, as is a similar screen of metal. But if it be tried against rapidly varying electrostatic force, its action lags. On account of this lagging, it is easily seen that the screening effect against periodic variations of electrostatic force will be less and less, the greater the frequency of the variation. This is readily illustrated by means of various forms of idiostatic electrometers. Thus, for example, a piece of paper supported on metal in metallic communication with the movable disc of an attracted disc electrometer annuls the attraction (or renders it quite insensible) a few seconds of time after a difference of potential is established and kept constant between the attracted disc and the opposed metal plate, if the paper and the air surrounding it are in the ordinary hygrometric condition of our climates. But if the instrument is applied to measure a rapidly alternating difference of potential, with equal differences on the two sides of zero, it gives very little less than the same average force as that found when the paper is removed and all other circumstances kept the same. Probably, with ordinary clean white paper in ordinary hygrometric conditions, a frequency of alternation of from 50 to 100 per second will more than suffice to render the screening influence of the paper insensible. And a much less frequency will suffice if the atmosphere surrounding the paper is artificially dried. Up to a frequency of millions per second, we may safely say that, the greater the frequency, the more perfect is the annulment of screening by the paper; and this statement holds also if the paper be thoroughly blackened on both sides with ink, although possibly in this condition a greater frequency than 50 to 100 per second might be required for practical annulment of the screening.

2. Now, suppose, instead of attractive force between two bodies separated by the screen, as our test of electrification, that we have as test a faint spark, after the manner of Hertz. Let two well insulated metal balls, A B, placed very nearly in contact, and two much larger balls, E F, placed beside them, with the shortest distance between E F, sufficient to prevent sparking, and with the lines joining the centres of the two pairs parallel. Let a rapidly alternating difference of potential be produced between E and F, varying, not abruptly, but according, we may suppose, to the simple harmonic law. Two sparks in every period will be observed between A and B. The interposition of a large paper screen between E F, on one side, and A B on the other, in ordinary hygrometric conditions, will absolutely stop these sparks, if the frequency be less than, perhaps, 4 or 5 per second. With a frequency of 50 or more, a clean white paper screen will make no perceptible difference. If the paper be thoroughly blackened with ink on both sides, a frequency of something more than 50 per second may be necessary, but some moderate frequency of a few hundreds per second will, no doubt, suffice to practically annul the effect of the interposition of the screen. With frequencies up to 1,000 million per second, as in some of Hertz's experiments, screens such as our blackened paper are still perfectly transparent, but if we raise the frequency to 500 million million, the influence to be transmitted is light, and the blackened paper becomes an almost perfect screen.

3. Screening against a varying magnetic force follows an opposite law to screening against varying electrostatic force. For the present, I pass over the case of iron and other bodies possessing magnetic susceptibility, and consider only materials devoid of magnetic susceptibility, but possessing more or less of electric conductivity. However perfect the electric conductivity of the screen may be, it has no screening efficiency against a steady magnetic force. But if the magnetic force varies, currents are induced in the material of the screen which tend to diminish the magnetic force in the air on their remote side from the varying magnet. For simplicity, we shall suppose the variations to follow the simple harmonic law. The greater the electric conductivity of the material, the greater is the screening effect for the same frequency of alternation; and the greater the frequency, the greater is the screening effect for the same material. If the screen be of copper, of specific resistance 1,640 sq. cm. per second (or electric diffusivity 130 sq. cm. per second), and with frequency 80 per second, what I have called the "mhoic effective thickness" * is 0·71 of a cm., and the current intensity at depth $n \times 0{\cdot}71$ cm. from the surface of the screen next the exciting magnet is ϵ^{-n} of its value at the surface.

Thus (as $\epsilon^3 = 20{\cdot}09$) the current intensity at depth 2·13 cm. is $\frac{1}{20}$th of its surface value. Hence we may expect that a sufficiently large plate of copper of $2\frac{1}{4}$ cm. thick or more will be a little less than perfect in its screening action against an alternating magnetic force of frequency 80 per second.

4. Mr. Willoughby Smith's experiments on "Volta-electric induction," which he described in his inaugural address to the Society of Telegraph Engineers of November, 1883, afforded good illustrations of this kind of action with copper, zinc, tin and lead screens, and with different degrees of frequency of alternation. His results with iron are also very interesting. They showed, as might be expected, comparatively little augmentation of screening effect with augmentation of frequency. This is just what is to be expected from the fact that a broad enough and long enough iron plate exercises a large magneto-static screening influence, which, with a thick enough plate, will be so nearly complete that comparatively little is left for augmentation of the screening influence by alterations of greater and greater frequency.

5. A copper shell closed around an alternating magnet produces a screening effect which, on the principle of Section 3 we may reckon to be little short of perfection if the thickness be $2\frac{1}{4}$ cm. or more, and the frequency of alternation 80 per second.

6. Suppose now the alternation of the magnetic force to be produced by the rotation of a magnet, M, about any axis. First, to find the effect of the rotation, imagine the magnet to be represented by ideal magnetic matter. Let (after the manner of Gauss in his treatment of the secular perturbations of the solar system) the ideal magnetic matter be uniformly distributed over the circles described by its different points. For brevity, call I the ideal magnet symmetrical round the axis, which is thus constituted. The magnetic force throughout the space around the rotating magnet will be the same as that due to I, compounded with an alternating force of which the component at any point in the direction of any fixed line varies from zero in the two opposite directions in each period of the rotation. If the copper shell is thick enough, and the angular velocity of the rotation great enough, the alternating component is almost annulled for external space, and only the steady force due to I is allowed to act in the space outside the copper shell.

7. Consider now, in the space outside the copper shell, a point, P, rotating with the magnet, M. It will experience a force simply equal to that due to M, when there is no rotation, and, when M and P rotate together, P will experience a force gradually altering as the speed of rotation increases until, when the speed becomes sufficiently great, it becomes sensibly the same as the force due to the symmetrical magnet, I. Now superimpose upon the whole system of the magnet and the point, P, and the copper shell, a rotation equal and opposite to that of M and P. The statement just made with reference to the magnetic force at P remains unaltered, and we have now a fixed magnet, M, and a point, P, at rest, with reference to it, while the copper shell rotates round the axis around which we first supposed M to rotate.

8. A little piece of apparatus, constructed to illustrate the result experimentally, is submitted to the Royal Society and shown in action. In the copper shell is a cylindric drum, 1·25 cm. thick, closed at its two ends with circular discs 1 cm. thick. The magnet is supported on the inner end of a stiff wire passing through the centre of a perforated fixed shaft, which passes through a hole in one end of the drum, and serves as one of the bearings; the other bearing is a rotating pivot fixed to the outside of the other end of the drum. The accompanying sections, drawn to a scale of three-fourths full size, explain the arrangement sufficiently. A magnetic needle outside, deflected by the fixed magnet when the drum is at rest, shows a great diminution of the deflection when the drum is set to rotate. If the (triple compound) magnet inside is reversed, by means

* Read before the Royal Society.

* "Collected Papers," vol. 3, Art. cii., § 35.

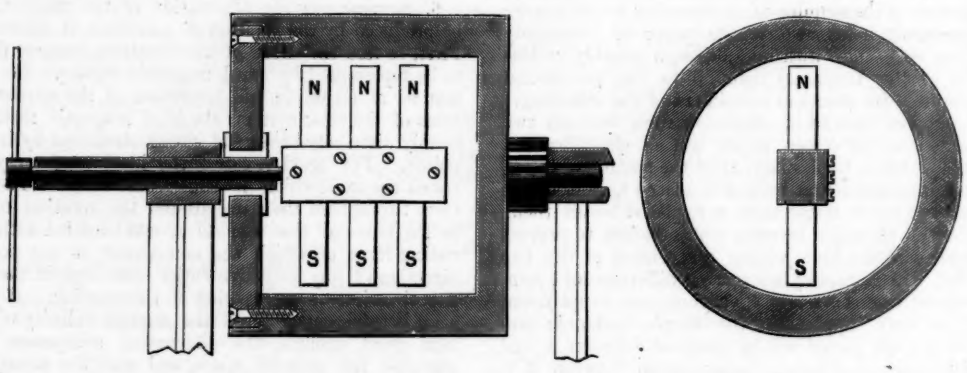
of the central wire and cross bar outside, shown in the diagram, the magnetometer outside is greatly affected while the copper shell is at rest, but scarcely affected perceptibly while the copper shell is rotating rapidly.

9. When the copper shell is a figure of revolution, the magnetic force at any point of the space outside or inside is steady, whatever be the speed of rotation; but if the shell be not a figure of revolution, the steady force in the external space observable when the shell is at rest becomes the resultant of the force due to a fixed magnet intermediate between M and I compounded with an alternating force with amplitude of alternation increasing to a maximum, and ultimately diminishing to zero, as the angular velocity is increased without limit.

10. If M be symmetrical, with reference to its northern and southern polarity, on the two sides of a plane through the axis of rotation, I becomes a null magnet, the ideal magnetic matter in every circle of which it is constituted being annulled by equal quantities of positive and negative magnetic matter being laid on it. Thus, when the rotation is sufficiently rapid, the magnetic force is annulled throughout the space external to the shell. The transition from the steady force of M to the final annulment of force, when the copper shell is symmetrical round its axis of rotation, is, through a steadily diminishing force, without alternations. When the shell is not symmetrical round its axis of rotation, the transition to zero is accompanied with alternations as described in Section 8.

11. When M is not symmetrical on the two sides of a plane through the axis of rotation, I is not null; and the condition approximated to through external space with increasing speed of rotation is the force due to I, which is an ideal magnet symmetrical round the axis of rotation. Suppose now a second shell enclosing the first to be caused to rotate about an axis precisely through and precisely perpendicular to the axis of rotation of the first shell. The magnetic force at I is by this second shell perfectly annulled through all the space external to it when the rotation is sufficiently rapid. Thus we arrive at the remarkable result that two closed conducting shells, rotating round axes exactly perpendicular to one another through one point, annul for all external space the magnetic force of any magnet whatever held fixed within the inner shell, when the rotation is sufficiently rapid.

12. Instead of the outer shell, an infinite plane disc of metal might be substituted with the same result; and a disc large enough to produce very nearly the same screening effect as if it were infinitely large is easily arranged for; and an experimental illustration of the result may be shown by a slight addition to the apparatus before the Royal Society; but there would be no special interest in this illustration. What would really be interesting would be a simple experimental illustration of screening against magnetic force by a rotating disc with a fixed magnet held close to it on one side. A bar magnet held with its magnetic axis bisected perpendicularly by the axis of rotation would have its magnetic force almost perfectly annulled by sufficiently rapid rotation at points in the air as near as may be to it, on the outer side of the disc, if the diameter of the disc exceeds considerably the length of the magnet.



PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.—April 23rd, 1891.

CONTINUATION OF DISCUSSION ON MR. ESSON'S PAPER, "NOTES ON THE DESIGN OF MULTIPOLAR DYNAMOS."

(*Authorised Abstract.*)

MR. MORDEY read a communication from Mr. W. B. SAYERS. Mr. Esson, he pointed out, had made no mention of slotted armatures in his paper, although many of the results contained in it could, by suitable modification, be applied to them. A mistake made by nearly all designers in considering this kind of machine, was to assume that they required much less magnetising power than ordinary smooth core machines. It was clear, however, that the ratios of the magnetising forces of the back and cross turns respectively on the armature, to those on the magnet, must have limiting values irrespective of the air space, which values could not be exceeded without giving rise to great distortion of field and serious sparking. Short air space machines had the disadvantage of a large induction in the armature at light loads, and the drop of volts with increase of current was serious. To make slotted armature machines satisfactory, they should have the same air space as those with smooth cores, that space being reckoned from the top of the iron projections. A slotted armature had therefore to be slightly larger than a smooth cored one for a given output. The *sine quâ non* of a good slotted armature machine was, that the sum of the areas of the teeth under a pole piece was not less than the section of the core. The coils of these machines being nearly surrounded by iron had a greater self-induction, and, therefore, more lead was usually required to prevent sparking. The advantages of such armatures were, that they combined positive driving and large clearance with considerable immunity from injury when removed for inspection or repair. To apply Mr. Esson's formulæ for the "volume of current" to slotted armatures, the air space should be reckoned from the tops of the projections. Obviously, the radial depth of the core must be measured from the bottom of the slots. Speaking of Prof. Thompson's remarks on the comparison of fig. 4 considered as a two and a four-pole machine, he said that, if correctly reported, he (Prof. Thompson) had apparently overlooked the fact, that for a two-pole machine the radial depth of the armature core would require to be doubled, and, if used as shown, the E.M.F. as a two-pole machine would not be much increased, but the external current would be halved.

MR. ESSON, in his reply to Prof. Thompson's objections to the expression "volume of current," said it was for simplicity and to avoid the confusion which had arisen from using "ampère turns," that he used the word "volume." The ampère turns on any armature were $\frac{w\,c}{p^2}$, where w was the number of wires counted all round the outside, c the total current, and p the number of poles; and the fraction of this which produced the cross field was $\frac{\phi}{360}\frac{p}{}$. This gives $\frac{w\,c}{p}\,\frac{\phi}{360}$ as the cross-magnetising ampère turns, and for simplicity he wrote it $\frac{v\,\phi}{360}$ where v represented $\frac{w\,c}{p}$. Respecting the comparison of a double magnet two-pole machine with a four-pole one, he said that the best comparison all depended on the size of the machine. Even if it were so large that it was desirable to make it of the four-pole type, there was still the alternative that it might be made two-pole, if the double horseshoe were practically split where the like poles abutted together. It would, he said, be a mistake to compare a small two-pole machine with a four-pole one, since a single magnet where it could be used, was better; and it was only when the air gap necessary to prevent sparking was greater than that needed for the copper that a multipolar machine was to be preferred. Speaking of the ratio of copper to iron in the machines shown in figs. 1 and 2, he pointed out that this ratio might be anything depending on the efficiency of the machines. Mr. Kapp had contended that the four-pole Gramme field, fig. 7, was lighter than

the double horseshoe shown in fig. 4, when the same materials were used; this he thought was a mistake, for owing to the greater length of yoke in the former, the weights were as 4 to 3. With reference to the relation between the temperature and peripheral velocity of armatures, he had no very precise data, but from some preliminary experiments he believed that connection was approximately represented by $c^\circ = \frac{w\ 330}{\cdot0005\ v\ s}$, where c° was the rise in degrees Centigrade, w the watts expended, v the velocity in feet per minute, and s the surface in square centimetres. He agreed with Mr. Andersen that increasing the number of sections diminished sparking, but he had wished to emphasise the fact that if the load exceeded a given value, no non-sparking position could be found for the brushes; this was true whatever the number of sections. He had then pointed out that in no actual machine did the load exceed half the limiting value. As regards Mr. Swinburne's remarks, he said he had no desire to hint, that because the formulæ were calculated, they were wrong. On the contrary, the calculations were most valuable, but the equations could only indicate relations and not absolute values, and one had to go to practice to obtain data. He entirely agreed with Mr. Crompton about the economy of material effected by making multipolar machines, for his own experience showed the saving to approach very closely the 40 per cent. mentioned by Mr. Crompton.

DISCUSSION ON "A FEW CALCULATIONS ON ELECTRIC SHOCKS FROM CONTACT WITH HIGH PRESSURE CONDUCTORS," by Major P. CARDEW, R.E., member.

(Authorised Abstract.)

Dr. FLEMING said the subject treated of was of great practical importance when dealing with pressures exceeding 100 volts. Considerable misapprehension existed on the subject, for it was commonly considered that high pressures were intrinsically dangerous. This, however, was not the case, for Mr. Latimer Clark showed, years ago, a person could, without injury, receive a shock from hundreds of thousands of volts, provided the quantity of electricity passed through the body was not large. To get a serious shock such as would cause physiological damage, it was evident that some appreciable current was necessary. The amount required to produce painful sensations differed greatly both with different subjects and with the portions of the body through which the current was passed. Some years ago he had tested himself and found that 4 or 5 milliampères passed through the head produced "swimming in the head," whereas, from hand to hand he could tolerate 20 to 30 milliampères. Some persons might, he thought, be able to take 20 milliampères through the head. It is not at all unlikely that one-third of an ampère, probably less, passed through any vital organ would prove fatal. Referring to the question as to how the body acts towards the current, whether like a condenser, voltameter, or resistance, he said that the condenser effects were small, but, undoubtedly, it acted like a voltameter or secondary battery, for it could be polarised and a current subsequently obtained from it. Measurements of resistance depended greatly on the character and humidity of the skin. At Cambridge, where many experiments were made, it was found that the resistances of boating men from hand to hand were unusually high, and to eliminate, more or less, the difficulty of obtaining good contact, Maxwell suggested that the hands be blistered and connection made by pushing needles through the skin. The experiments were not continued. On the subject of whether a person making a joint in active high pressure mains, on an insulated chair, he said that if the body acts like a condenser, serious physiological damage might result from a contact under such circumstances, particularly if the current be alternating. The theory that some such condenser action existed was supported by the fact that moderate alternating or fluctuating pressures produced more painful sensations than equal continuous ones. If, however, physiological damage was the result of the electrolysis of some vital tissues, then direct currents would be more likely to prove fatal than alternating currents of the same strength.

One interesting fact brought out in Major Cardew's paper, viz., that the outer conductor of a concentric cable is naturally at zero potential, he had verified experimentally. He considered it an important point in favour of concentric conductors for high pressure distribution, and thought the fact ought to be more generally known. In conclusion he said that quantitative information and data respecting electric shocks, accidental or otherwise, were greatly needed before the subject could be thoroughly investigated.

Mr. H. NEWMAN LAURENCE said he had made many experiments on the resistance of persons and on the currents required to produce discomfort, &c. He would not like to have passed the four or five milliampères, mentioned by Dr. Fleming, through his own head, and thought it improbable that some persons might withstand 20 milliampères through that part of the body. The direction of the current with respect to the brain was, however, of great importance. Transverse currents produced most effect, and he found it possible to withstand two or three times as much current when passed longitudinally. Although the pain experienced by the passage of such currents might be slight, the after results might be serious. In commenting on the difficulty in obtaining reliable information in cases of accidents or other serious shocks, he expressed a hope that the Institution might be able to collect such statistics as completely as possible. Generally, he said the conditions as to area of contact, condition of skin, earth connection, &c., were not at all clear, and no idea could be gathered from ordinary information as to the actual current passed. He agreed with Dr. Fleming that it was the quantity passed through the body that was the important factor. To know the pressure was not essential, and the ordinary statements that persons received shocks from a certain number of volts, were generally misleading.

Mr. ADDENBROOKE remarked that in connection with the Grosvenor Gallery installation he had experienced shocks, and once made an overhead joint on a 2,500-volt circuit, with the pressure on. To do this he had a strong teak bracket fixed to the post, and all the wood and metal work near was covered with India-rubber sheating. Special tools with insulating handles were used and a dry day chosen. When he touched the conductor faint blue sparks passed, but nothing to produce discomfort. On another occasion he unconsciously put his hand across a high pressure switch, and although he had no recollection of experiencing any shock he was thrown down. Several men he knew, had received serious shocks from a 2,500-volt circuit. In one case a man was putting up a transformer, and clinging to an iron bracket that had been recently cemented into a wall with one hand, he reached up to one of the primary conductors with the other. The pressure was on, and the man was fixed in that position until he was pulled down by his comrades. His hands were severely burnt, and he received a severe shock to the system. In another case when rearranging a customer's service lines, an arc started through a crack in the insulation to a man's hand in which he was holding the wire. He was fixed to the post for some time before being released. The hand was badly burnt, and looked as if a red hot poker had been laid on for some time. He (Mr. Addenbrooke) believed that the arc was started by perspiration from the man's hand penetrating the crack and making connection through his body to the post. So far as he knew this man's constitution was not permanently affected by the shock.

Mr. MORDEY remarked that at the Brush Works they had made high pressure electrical machinery for the last 10 years, and although their testing arrangements were of a temporary kind, and much unskilled labour was employed, they had never had a serious accident due to electrical machinery. Only one instance had occurred in which a man was made insensible. This was a lamp trimmer who, in taking down a lamp, completed the circuit of a No. 8 Brush machine through his body. A bright arc was seen to pass for some time between the lamp and his hand. He fell from the ladder and had received a severe turn and shock, but although a large current must have passed, he suffered no permanent injury to the system. He himself once disconnected the circuit of a No. 7 machine, and held the wires, one in each hand, thus completing the circuit. At the time he was conscious of having an idea that the brushes of the machine needed shifting to reduce the great sparking that occurred, but he did not know what he had done until after he was released by stopping the machine. Referring to Dr. Fleming's remarks about making joints in high pressure mains or by means of insulated chairs, he said there was no difficulty whatever in doing so. The average person had not sufficient capacity to obtain a dangerous shock. At the Brush works they constantly handled high pressure wires with bare hands and rarely found it necessary to take any precaution, unless the pressure exceeded 2,000 volts. Then they merely stood on India-rubber mats. A packer once in their employ was particularly insensitive to fairly large pressures, for he commonly took hold of terminals of machines giving about 800 volts. His experience with concentric cables confirmed the statements made by Major Cardew and Dr. Fleming, viz., that the outer conductor was at zero potential. In considering the shocks obtainable from a given source, he said the internal resistance of the source was of great importance, and as an instance adduced the fact that vacuum tubes, although requiring induction coils giving sparks corresponding to many thousands of volts to work them, were blown to pieces when put on a 1,000-volt alternator.

Mr. H. HUMAN asked Dr. Fleming that as he considered danger more a question of current than of pressure, whether he would prefer to take hold of the primary terminals of a transformer rather than those of the secondary.

Prof. AYRTON pointed out that the fact of the outside of a concentric cable being at zero potential depended on the outside being near earth. It would not necessarily be so if it was far removed from other conductors.

Prof. PERRY enquired whether the whole concentric system and generator, if insulated, might not be charged to, say, a million volts above the earth potential.

Major CARDEW, in reply to Prof. Perry, said this could only be done by means of an external source, and in his calculations he had postulated the absence of such sources. There was, he said, no doubt that considerable polarisation could be produced in the human body, for he found that its resistance to steady currents goes down as the pressure increases, and tends to a value which is approximately the same as that found by measurements with alternating currents. For small pressures, however, the effects produced by alternating or fluctuating pressures were much greater than with steady ones. He called Mr. Addenbrooke's attention to a fact pointed out in his paper viz., that touching a conductor of a (say) 2,500-volt system, did not necessarily imply that a shock corresponding to that pressure was, experienced, for the act of contact in reducing the resistance to earths would probably lower the difference of potential to about one third, of the stated value.

Physical Society, April 17th, 1891.

Prof. W. E. AYRTON, F.R.S., President, in the chair.

THE following communications were made:—

"ON A PROPERTY OF MAGNETIC SHUNTS," by Prof. S. P. THOMPSON, D.Sc.

After referring to a few instances in which magnetic shunts are employed, as, for example, the ordinary magnetic medical coil, and Trotter's constant current dynamo, he said that the particular property he wished to speak of was the time taken for such a shunt to lose its magnetism as compared with the other branch of the magnetic circuit. If these times were very different, unexpected results might be produced, and these might be regarded as being due to a kind of

magnetic time constants. Short pieces, as was well known, demagnetise much more rapidly than long ones, particularly if the latter form, or be part of, a closed magnetic circuit. Hence in alternators, such as Kingdon's Keeper dynamo, in which both magnets and armature are stationary, it was important that the revolving keepers should be short. The most important application of a magnetic shunt occurred, he said, in d'Arlincourt's relay described in Vol. IV. *Journal of the Society of Telegraph Engineers and Electricians*, and shown diametrically in fig. 1. In this relay the polarised tongue, T, plays

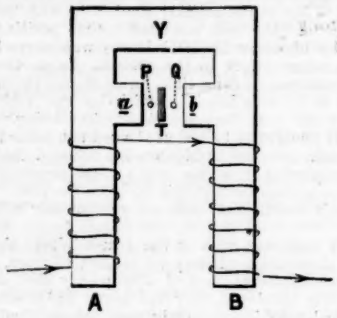


FIG. 1.

between two projections, *a* and *b*, near the yoke, Y, and it is claimed to have a quicker action than ordinary kinds. The reason of this the author explained as follows: When a current flows through the coils, the greater part of the magnetic lines pass through the yoke, but a few leak across from *a* to *b* and move the tongue against the contact, P. On stopping the current the magnetism in the extremities, *a* and *b*, dies away much more rapidly than in the yoke, consequently the direction of the field between *a* and *b* is reversed and the tongue, T, thrown back against the stop, Q.

Prof. PERRY asked if any experiments had been made to test whether the throwing back actually occurred. He also enquired whether such action would be augmented or otherwise by having a thick copper tube round the yoke or by laminating the iron.

Mr. BLAKESLEY asked if placing a yoke across *a b* would not improve the action.

The PRESIDENT said he would be glad to know whether the relay was any more sensitive than an ordinary one as regards the ampère turns or the watts required to actuate the instruments. In India he remembered that they used inductive coils, shunting the ordinary relays in order to expedite the action and to avoid confused signals arising from the electrostatic capacity of long lines.

In reply, Prof. THOMPSON said he had tried an experiment on a horse-shoe electro-magnet, and found evidence of throwing back when working near the bend or yoke. Putting a yoke across *a b* would, he thought, tend to neutralise the effect desired.

"AN ALTERNATING CURRENT INFLUENCE MACHINE," by JAMES WIMSHURST.

This machine* consists of a varnished glass disc, with or without metallic sectors, mounted on an axis, and rotating within a square wooden frame fixed in the plane of the disc. The frame carries four square glass plates, each of which has one corner cut away so as to clear the base of the disc. These plates are placed one at each corner of the frame, alternately on the two sides, and the disc revolves between them. There are thus two plates on one side of the disc situated at opposite ends of a diagonal of the frame, and two on the other side of the disc at opposite ends of the other diagonal. Tin-foil sectors fixed to the outer sides of the plates act as inductors, and wire brushes connected with them touch the disc about 90 degrees behind the centre of the inductors.

The peculiarity of the machine is that although sparks can be readily obtained from it, a Leyden jar cannot be charged by bringing it to one of the terminals. From this the author concluded that the electricity produced was alternately of positive and negative sign, and this he showed to be the case by means of an electroscope. The alternations, he said, occurred about every three-quarters of a revolution, the suspended paper discs which he used as an electroscope remaining apart for that period and collapsing during the next quarter of a turn.

Using discs with various numbers and sizes of sectors, the author finds that the smaller the sectors and the fewer the number, the greater the quantity of electricity produced. Plain varnished glass is the best in this respect. Such a disc, however, does not excite itself quite so freely as one having numerous metallic sectors.

By removing two of the inductors and placing an insulating rod carrying collecting brushes at its ends, across a diameter of the disc, the machine was used to produce direct currents. Numerous discs and various shaped inductors accompanied the machine, by means of which a Holtz, Voss, or ordinary influence machine could be imitated.

Prof. S. P. THOMPSON congratulated the author on the most interesting and puzzling machine he had brought before the society. He enquired if the machine would work if the direction of rotation were reversed, or if two of the inductors were removed, and also whether all the four inductors are electrically of the same sign at the same instant.

In reply, Mr. WIMSHURST said the machine would not excite if the direction of rotation be changed without also changing the direction of the brush arm, but it would work as a direct current machine when two inductors were removed.

* See last week's REVIEW.

"ON ERECTING PRISMS FOR THE OPTICAL LANTERN, AND ON A NEW FORM OF ERECTING PRISM MADE BY MR. AHRENS," by Prof. S. P. THOMPSON, D.Sc.

The ordinary form of erecting prisms, viz., a right-angled isosceles one, was, the author pointed out, open to the objection that the top halves of the faces enclosing the right angle were nearly useless, for only the light which after the first refraction is totally reflected by the hypotenuse face can be utilised. The fraction of the side which is useful varies with the refractive index, being ·46 when $\mu = 1{\cdot}5$, and ·525 when $\mu = 1{\cdot}65$. To increase these proportions, prisms with angles of 105° and 126° have been used by Wright and others, and in some cases the prisms have been truncated. With such large angles much light is lost by reflection. Bertin employed two truncated right-angled prisms placed base to base with an air film between them. Nachet has also made erecting prisms for microscopes, in which internal reflections occur from faces inclined at an angle of 81° to each other. This form of prism suggested to Mr. Ahrens the new form now shown, and which may be described as a long right-angled prism whose ends are cut off so as to be parallel to each other and inclined at 45° to the hypotenuse face. The longitudinal acute angles not being required, are truncated.

Light falling parallel to the axis on one end of the prism is refracted, and after internal reflections emerges parallel but perverted. It is claimed that this form of prism gives, weight for weight, a larger angular field than any previously made.

The performance of the new form of prism and also of the ordinary form was tested before the Society.

At the close of the meeting, Dr. Atkinson, who had previously taken the chair, announced that the next meeting would be held at Cambridge on May 9th, instead of May 8th as previousiy intended.

NEW PATENTS—1891.

6,276. "Electric locking devices for the gear wheels of motors of electric cars (or carriages)." G. W. BLANCHARD. Dated April 13th. (*Complete.*)

6,292. "An improved form of insulator for use with electrical currents." H. W. MILLER. Dated April 13th. (*Complete.*)

6,298. "Improvements of armatures of dynamo-electric machines and motors." J. WODICKA. Dated April 13th.

6,318. An improvement relating to medico-electric batteries." N. MITCHELL." Dated April 13th.

6,347. "Improvements in alternating current transformers." G. T. TUGWELL and E. A. MITCHELL. Dated April 14th.

6,372. "Improvements in electric time calls." R. VARLEY, Jun. Dated April 14th.

6,378. "Improvements in and relating to electric motors." C. J. VAN DEPOELE. Dated April 14th. (*Complete.*)

6,382. "A new or improved phonograph clock." W. E. WOODBURY. Dated April 14th.

6,397. "Improvements in phonophoric telegraphy." C. LANGDON-DAVIES. Dated April 14th.

6,402. "Improvements in microphonic or telephonic transmitters." A. T. COLLIER. Dated April 14th.

6,474. "Improvements in materials or compounds to be used as substitutes for wood, vulcanite, ebonite, and the like, in the manufacture of articles such as electrical insulators, cells for electrical accumulators, boxes, door handles, toys, and other articles of the like kind." W. GRITTEN and J. LANG. Dated April 15th.

6,485. "Improvements in dynamo-electric and electro-dynamic machines." A. I. GRAVIER. Dated April 15th.

6,489. "A combined ceiling switch, cut-out, and ceiling rose for electric incandescent lamps." W. R. PRYKE. Dated April 15th.

6,492. "An Improved holder and shade for electric glow lamps." C. BARTER. Dated April 15th.

6,502. "Improvements in galvanic batteries." J. VON DER POPPENBURG. Dated April 15th.

6,509. "The manufacture of ferric chloride from waste pickle from galvanising works." J. W. WILSON and C. H. G. HARVEY. Dated April 16th.

6,517. "Improvements in electric light switches." C. M. DORMAN and R. A. SMITH. Dated April 16th.

6,559. "Improved electric bell push." J. M. NICOL. Dated April 16th.

6,614. "Taylor's patent automatic electric bell signals for the prevention of collisions and accidents in foggy weather, or through engine drivers running past danger signals." H. R. TAYLOR. Dated April 17th.

6,633. "Improvements in or relating to electric meters." F. TEAGUE. Dated April 17th.

6,655. "Improvements in supports for telegraph insulators." J. C. FULLER and G. FULLER. Dated April 17th.

6,660. "Improvements in the method of distribution of electrical energy and in apparatus incidental thereto." S. Z. DE FERRANTI. Dated April 17th.

6,677. "Improvements in the construction of magneto-electro medical." D. T. PIOT. Dated April 18th.

6,730. "Improvements in dynamo-electric machines." W. M. MORDEY. Dated April 18th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

11,480. "Improvements in dynamo-electric machines and electro-motors." ELIHU THOMSON. Dated July 22nd. 8d. In the machines embodying the invention, the inventor makes both the inducing and the induced current—that is, the current in the field conductor and what corresponds to the armature conductor—traverse stationary coils with fixed terminals, the only part of the machine which revolves being an iron mass suitably constructed. 17 claims.

12,221. "An improved apparatus for the measurement of electrical energy." H. H. LAKE. (Communicated from abroad by E. Weston, of America.) Dated August 5th. 6d. The instrument embodies a fixed or stationary coil in the field of force on which is pivoted a vibrating coil, the said coils being electrically connected. The movable coil on the passage of a current through the circuit including both coils, assumes an angular position, depending upon the difference of potential between the terminals of the circuit, and the extent of angular displacement of the movable coil is shown by an index or pointer on a suitable scale. 1 claim.

14,269. "Improvements in electrical signalling apparatus for police service and the like." R. D. RADCLIFFE. Dated September 10th. 8d. Consists in arranging insulating pieces, recesses, or spaces in the signal disc or wheel in such a manner that when the latter is rotated under the action of clockwork or otherwise, the brush or contact arm will be moved into the path of isolated insulating pieces, recesses, or spaces arranged in groups in different concentric circles, instead of into the path of insulating pieces or recesses, arranged in different radial lines as heretofore. 8 claims.

CORRESPONDENCE.

Electrostatic Inductive Capacity.

Very full figures have been published relating to the electrical values of the recently completed London-Paris Telephone line, but there is one point in connection with these figures which is not at all clear, and that is the accuracy of the assumption that the total electrostatic inductive capacity of a line worked on metallic circuit is half what it would be if worked on a single wire with earth as return. Mr. W. H. Preece, indeed, in his classical paper read before the Royal Society in March, 1887, states this to be a fact, and speaks of it as an interesting consequence of Thomson's law of speeds (*vide* ELECTRICAL REVIEW, vol. XX., p. 225).

If there be a line worked on a single covered wire with earth return (one core in a cable, for instance), and if the earth return be replaced by a second covered wire similar to the first, it is manifest the total capacity of the circuit will be halved, but the same result is by no means self-evident when aerial wires are in question.

The weight given for the wires on the line from London to St. Margaret's Bay shows them to be about 4 mm. in diameter, and the calculated capacity of a well-insulated 4 mm. wire suspended at a height of 20 feet above the ground, is about 0·012 mfd. per mile. The actual capacity is said to be 0·015 mfd. per mile, the increase over the calculated value being due to the earth wires on the poles. The calculated capacity of two well-insulated 4 mm. wires suspended at a uniform distance of 14 inches apart (the distance separating the wires on the London-St. Margaret's line) is about 0·009 mfd. per mile, and to reduce this to 0·006 mfd. per mile (*i.e.*, to half the capacity of a single wire) it would be necessary to separate the two wires by quite an impracticable distance. The results of actual tests on some French lines, recently published in the *Annales Télégraphiques* (vol. xvii., p. 499) go to show that the total electrostatic inductive capacity of an aërial line is varied but little, whether it be worked on metallic or single circuit, and it is probable that, as in the case of the single wire, the actual capacity of the metallic circuit is higher than that indicated by theory.

It would be interesting to know what proof can be given of the truth of the assumption, that on metallic circuit the total capacity is halved.

Mfd.

April 27th, 1891.

[We refer this correspondent to our "Notes" columns.—EDS. ELEC. REV.]

Elmore Copper.

In your issue of the 10th inst., you reprinted a letter written by Mr. Alexander Watt to a financial paper on the 4th inst., for the purpose of illustrating the bad qualities of the tubes made by the Elmore process, in which Mr. Watt states as a fact that "if a burnisher passes over the surface of a revolving iron mandrel coated with copper, it leaves a bright and highly polished or burnished surface to receive the next deposit with which it has no cohesion, and thus becomes a distinct and separate layer or film, and this deposit of non-adherent, and, indeed, laminated metal layer upon layer, goes on throughout the entire body of the metal deposited, rendering it totally unfit to withstand even a moderate heat without coming to grief in some way—disintegrating, in fact." Will you kindly allow me to state, if it be necessary to do so after the reports of so many eminent experts to the contrary, that this statement, instead of being a fact, is absolutely untrue, and, in support of my assertion, I am willing to deposit with any approved bank or person the sum of £500, provided Mr. Watt, or any champion of his, does the same; and I will undertake to make an Elmore tube under the supervision of any well-known expert, and I will forfeit this sum to Mr. Watt, or to a recognised charity, if this tube shows any sign of foliation or lamination, even when subjected not only to a "moderate heat," but to a temperature up to the point of fusion, Mr. Watt to likewise forfeit the same sum in the event of his contention being proved wrong. As a matter of fact, by the Elmore burnishing process the copper is made perfectly homogeneous, but by a modification of conditions, the copper may be deposited in superposed layers upon one mandrel, and it may be laminated to any extent at will. We take advantage of this latter fact in our patented process for the manufacture of copper sheets.

William Elmore.

London, *April 28th*, 1891.

[We regret that the conflicting views of our correspondents on this interesting technical question can only be determined by the aid of methods more familiar to readers of sporting papers than to those of the ELECTRICAL REVIEW. We are glad to receive from our correspondents information of interest, but we cannot undertake to be the medium of communication for challenges involving stakeholders, &c., and we will therefore not trouble Mr. Watt for any reply to the above. Until time and experience shall have settled the matter it must remain in the stage of assertions. Mr. Watt says that by the burnishing process the copper is deposited in layers, which remain layers, and he gives the reasons on which his conclusion is based. Mr. Elmore admits that is so if they want it to be so, but it needs a modification of conditions from the Elmore burnishing process by which the copper is made perfectly homogeneous.—EDS. ELEC. REV.].

The Lane-Fox Patents.

I shall be much obliged if you will allow me through your columns to offer a few observations for the purpose of explaining the report of the action of the Kensington and Knightsbridge Electric Supply Company *v.* the Lane-Fox Electrical Company, which appeared in the *Times* of last Saturday.

This report, although accurate as far as it goes, is calculated to convey to anyone unacquainted with the history of the matter a very misleading conception of the actual state of the case. Briefly stated, the facts are as follows:—The patent in dispute covers the method of electric light distribution now very generally in use, and which is known as the "direct supply system."

This patent was till quite recently held by the Brush Electric Light Company, and was the subject of litigation between that company and the Edison-Swan Electric Light Company. Before, however, the case came into Court, a settlement was arrived at between the two companies, whereby the Edison-Swan Company acknowledged the validity of the patent, and accepted a license from the Brush Company. What the precise terms of this license may be I have not been able to ascertain. Suffice it to say that, inasmuch as it raised questions between the Brush Company and myself, a new agreement was entered into between us, by which the patent was made over to me subject to this Edison-Swan license, the benefit of which was retained by the Brush Company. In this way I became entitled to royalties accruing from the use of the patent by the trade generally with the above exceptions. I not unnaturally concluded that the patent having been ac-

knowledged by two such important firms as the Edison-Swan Company and the Brush Company, and that having the strong support of by far the most eminent scientific and legal authorities of the day (including Sir William Thomson, President of the Royal Society; Dr. Silvanus Thompson, Prof. Perry, Mr. W. H. Preece, Mr. Latimer Clark, Sir Richard Webster, Mr. Fletcher Moulton and many others), it would be generally acknowledged by the various infringers, without any further dispute. Accordingly a limited company was formed, with the nominal capital of £100, for the purpose of holding the patent and of apportioning certain interests therein. Instead, however, of honourably accepting the situation, a movement was started in the trade, at the instigation of the Kensington and Knightsbridge Company, for organising an opposition to the patent. After all our conciliatory overtures to this trade combination had failed, an action was started against the Kensington and Knightsbridge Company in the joint names of myself and my company, and for this action we retained the services of the Attorney-General and Mr. Moulton, Q.C., for both of whom I had a general retainer of long standing.

Now the Kensington and Knightsbridge Company, holding also a general retainer (though of long subsequent date to my own) for these same counsel, claimed their services against us, because, according to the rules which govern these matters, my prior retainer was invalidated by the fact of my company being made party to the suit.

The consequence was that in order that we might continue to have the services of these counsel, the original action had to be withdrawn and a new one instituted in my own name alone. These facts will explain how it came about that we were placed in the rather curious position indicated in the report of the proceedings before Mr. Justice Sterling.

St. G. Lane-Fox.

April 28th, 1891.

Concentric Wiring.*

To the Editor of the POST MAGAZINE.

Sir,—As the concentric wiring of buildings is now engaging the attention of fire office officials, and as the system differs materially in important features from that commonly in vogue and for which all existing insurance rules are solely framed to meet, I hope no apology is needed in bringing this subject under the notice of your readers. We are at present so wedded by custom to ordinary two-wire work that when meeting with a system that does not conform with the usual requirements in the matter of house-wiring, we naturally view the new comer with a certain amount of distrust and suspicion. But do not let us condemn in haste what may upon maturer consideration prove rather a boon than otherwise from our particular point of view. Let us therefore, in the first place, briefly consider in what respects the two systems mainly differ.

In ordinary two-wire work, with lamps in simple parallel, we carry two insulated conductors, kept rigidly apart in wood casing, forming what are technically known as the "positive" and "negative" poles, and between which there is usually a difference of potential of 100 volts. We, in short, so arrange matters that there shall be no electrical connection whatever between those conductors other than through the lamps. Now under these conditions it is clear that the electrical stress or strain lies between those conductors, and is therefore in a measure *external* to the respective cables or wires of the system.

On the other hand in concentric work the "positive" conductor is carried inside the "negative" conductor, with insulation between, forming a complete cable, the one "pole" thus completely surrounding and electrically screening the other. Here then the electrical strain, or stress, is between the centre core and the outer metallic covering of the cable—hence it is in this instance *internal* and confined to the cable. Thus it matters not what contact the outer or negative conductor may make with surrounding conducting matter, and therefore no need for wood casing or other protection. It is impossible, under these conditions, for the "positive" to make earth excepting through the "negative," and that brings about what is technically called a *short* circuit, against which we can absolutely provide.

On the score of insulation, the concentric easily bears the palm.

But this is not the only advantage. In our existing rules we provide liberally for cut-outs, in the fond belief that they will protect us from all electrical evils. As is well known, however, in two-wire work they do nothing of the kind. A fusible cut-out acts only in the event of an excess of current. It will not protect us against dangerous heating, due to bad joints, fractured wires, or the innumerable imperfect connections throughout an installation, until serious damage is done. But with a concentric cable with only the insulating material (which should be as thin as possible, with the requisite resistance) between the two conductors, it is scarcely possible that either can sustain injury in the manner referred to for any appreciable time without destroying the insulation and producing the requisite "short circuit," thus bringing the cut-out into operation.

So that by using a concentric system of wiring we not only get rid of wood casing and its attending evils, but we at the same time vastly enhance the value of our cut-outs.

Whilst on this subject let me refer to news that has lately reached us from Berlin. The "Berliner Electricitäts Werke," with an experience in electrical wiring second to none—supplying, as they do, over 100,000 lamps—are revising their wiring rules, and if report be true, they are doing so in a very thorough manner. They now condemn the use of wood casing; but the greatest novelty is in the wire specified for. This amounts to a twin cable with very slight mechanical insulation between the two wires—such as cotton or jute, but the whole overlaid with the usual rubber and tape as a protection against moisture. By this arrangement any injury or fault in the conductors must bring about a short-circuit, blowing the fuse, and thus saving a conflagration.

In the light of our English rules this appears little short of madness, but it will be observed there is singular method in the madness of our German friends. The same effect, however, is equally obtainable with a concentric cable, and in a better manner.

I will now refer to what appears essential in a concentric system, and what are its drawbacks.

In the first place, it is evident that the concentricity must extend to every detail—from dynamo to lamp—including all switches, cut-outs and lamp fittings. To effect this, and at the same time to obtain a perfect mechanical and electrical joint, requires much scheming. But it is done, and well done. A concentric wired installation is the nearest approach to gas fitting I know of, and there is somehow a charming simplicity in a gas pipe not to be denied.

At first sight a bare return, forming the outer armour of the cable and affording protection to the insulation, appears altogether wrong. It is, nevertheless, feasible and safe, and is an arrangement frequently met with in ship lighting, where the lamp fitting forms the return to a single wire system, carried within it. And yet no one has ever experienced any unpleasantness in handling such a fitting, nor is ever likely to. It is desirable, however, that the negative be thoroughly well "earthed," to provide against certain contingencies, when it may be handled with perfect impunity under any circumstances.

The only drawback, as far as I know, to the more general use of the concentric system of wiring is in the fact that it must not be used in combination with another system, and for obvious reasons. There must be no mixing of the two, where both derive their supply from the same source; hence it is scarcely applicable in installations off a public supply. But in private and self-contained installations, independent of any external supply, I know of no system of wiring, when properly carried out, that gives such protection to both life and property as the concentric.

I venture to put forward these remarks in the hope they may lead to a useful discussion upon a system at present little understood or appreciated, and which unfortunately threatens to become another bone of contention.

I am, Sir, yours obediently,

H. Human, *A. I.E.E.*

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* This letter is referred to in our leading columns.—EDS. ELEC. REV.